$2—

D 71683

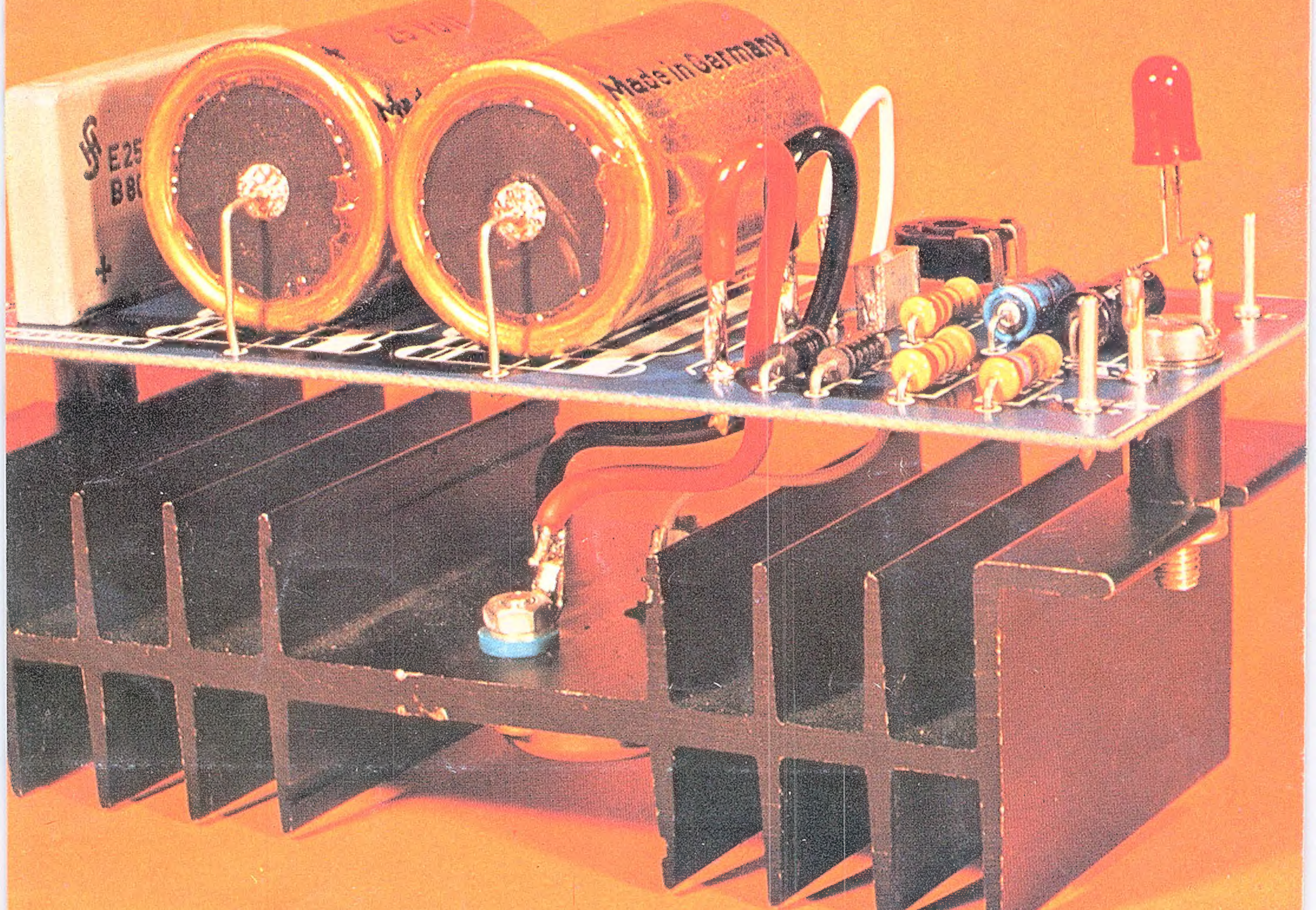
elektor

up-to-date electronics for lab and leisure

93

January 1983

75 p.
IR 112 p. (incl. VAT)
$ 2.50



countdown and d.c. protection for the CRESCENDO ·
BA computer supply · mate the darkroom computer
to the PCS 2000 · improve your connections wit
milli-ohmmeter · digital audio - a giant ste
small leap ?

TTLs

7400	11p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	18p
7407	18p
7408	14p
7409	14p
7410	14p
7411	16p
7412	14p
7413	16p
7414	18p
7416	18p
7417	18p
7420	14p
7421	18p
7422	20p
7423	18p
7425	18p
7426	18p
7427	18p
7428	18p
7430	14p
7432	18p
7433	22p
7437	22p
7438	22p
7439	25p
7440	15p
7441	55p
7442A	30p
7443	70p
7444	70p
7445	50p
7446A	50p
7447A	36p
7448	45p
7450	15p
7451	15p
7453	15p
7454	15p
7460	15p
7470	30p
7472	25p
7473	25p
7474	18p
7475	22p
7476	25p
7480	48p
7481	120p
7482	65p
7483A	38p
7484	65p
7485	60p
7486	18p
7489	170p
7490A	20p
7491	35p
7492A	25p
7493A	24p
7494	35p
7495A	35p
7496	35p
7497	90p
74100	80p
74104	50p
74105	55p
74107	22p
74109	25p
74110	30p
74111	55p
74112	170p
74116	50p
74118	55p
74119	60p
74120	60p
74121	25p
74122	30p
74123	36p
74125	30p
74126	30p
74128	36p
74132	30p
74136	28p
74141	55p
74142	175p
74143	200p
74144	200p
74145	40p
74147	75p
74148	60p
74150	50p
74151A	36p
74153	36p
74154	50p
74155	40p
74156	36p
74157	30p
74159	75p
74160	40p
74161	40p
74162	40p
74163	40p
74164	45p
74165	45p
74166	48p
74167	150p
74170	120p
74172	250p
74173	50p
74174	55p
74175	50p
74176	40p
74177	45p
74178	70p
74180	40p
74181	115p
74182	40p
74184	90p
74185A	90p
74186	470p
74188	250p
74190	45p
74191	45p
74192	45p
74193	45p
74194	40p
74195	40p
74196	40p
74197	40p
74198	80p
74199	80p
74221	55p
74251	45p
74259	100p
74265	45p
74278	140p
74279	40p
74283	50p
74284	160p
74285	160p
74290	75p
74293	80p
74298	100p
74365A	30p
74366A	30p
74367A	30p
74368A	30p
74390	75p
74393	90p
74490	95p

74LS SERIES

74LS00	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS09	12p
74LS10	13p
74LS11	13p
74LS12	13p
74LS13	20p
74LS14	25p
74LS15	12p
74LS20	13p
74LS21	13p
74LS27	13p
74LS30	13p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	14p
74LS42	30p
74LS47	36p
74LS51	14p
74LS55	15p
74LS73	18p
74LS74	16p
74LS75	18p
74LS76	18p
74LS83	38p
74LS85	40p
74LS86	16p
74LS90	22p
74LS92	30p
74LS93	22p
74LS96	50p
74LS107	20p
74LS109	27p
74LS112	20p
74LS113	20p
74LS114	22p
74LS122	25p
74LS123	34p
74LS124	90p
74LS125A	24p
74LS126A	25p
74LS132	34p
74LS133	25p
74LS136	25p
74LS138	27p
74LS139	27p
74LS145	70p
74LS147	100p
74LS148	75p
74LS151	40p
74LS153	40p
74LS154	80p
74LS155	30p
74LS156	36p
74LS157	27p
74LS158	30p
74LS160A	36p
74LS161A	36p
74LS162A	36p
74LS163A	36p
74LS164	40p
74LS165A	50p
74LS166A	60p
74LS170	70p
74LS173A	55p
74LS174	40p
74LS175	40p
74LS181	90p
74LS190	36p
74LS191	36p
74LS192	36p
74LS193	36p
74LS194A	35p
74LS195A	35p
74LS196	45p
74LS197	45p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	55p
74LS245	75p
74LS247	70p
74LS248	55p
74LS249	55p
74LS251	30p
74LS253	30p
74LS257	30p
74LS258	35p
74LS259	55p
74LS266	20p
74LS273	55p
74LS279	30p
74LS283	40p
74LS293	40p
74LS299	180p
74LS323	160p
74LS324	150p
74LS348	90p
74LS352	60p
74LS353	60p
74LS363	140p
74LS364	140p
74LS365A	30p
74LS367A	30p
74LS368A	30p
74LS373	55p
74LS374	55p
74LS375	45p
74LS377	70p
74LS378	70p
74LS390	45p
74LS393	45p
74LS399	160p
74LS445	100p
74LS540	90p
74LS541	80p
74LS610	£19
74LS640	100p
74LS641	100p
74LS642	100p
74LS643	100p
74LS644	100p
74LS668	100p
74LS669	100p
74LS670	120p
74LS682	300p
74LS684	300p
74LS687	400p

74C SERIES

74C244	160p
74C245	180p
74C373	160p
74C374	160p

4000 CMOS

4000	10p
4001	10p
4002	12p
4006	50p
4007	14p
4008	36p
4009	24p
4010	24p
4011	11p
4012	16p
4013	20p
4014	48p
4015	40p
4016	20p
4017	32p
4018	45p
4019	25p
4020	48p
4021	40p
4022	45p
4023	13p
4024	32p
4025	13p
4026	80p
4027	20p
4028	40p
4029	45p
4030	15p
4031	125p
4033	125p
4034	140p
4035	45p
4036	275p
4037	110p
4038	110p
4039	290p
4040	40p
4041	40p
4042	40p
4043	40p
4044	40p
4045	105p
4046	50p
4047	45p
4048	50p
4049	24p
4050	24p
4051	45p
4052	60p
4053	50p
4054	90p
4055	90p
4056	90p
4059	450p
4060	55p
4063	90p
4066	27p
4067	225p
4068	14p
4069	14p
4070	14p
4071	14p
4072	14p
4073	14p
4075	14p
4076	48p
4077	16p
4081	14p
4082	15p
4086	40p
4089	125p
4093	24p
4094	90p
4095	75p
4096	70p
4097	290p
4098	90p
4099	100p
40100	200p
40101	130p
40102	140p
40103	170p
40104	90p
40105	110p
40106	36p
40107	60p
40108	450p
40109	100p
40110	275p
40114	225p
40244	160p
40245	180p
40257	160p
4502	60p
4503	45p
4507	35p
4508	130p
4510	45p
4511	45p
4512	48p
4514	110p
4515	110p
4516	55p
4518	40p
4519	30p
4520	50p
4521	90p
4526	60p
4527	60p
4528	50p
4531	125p
4532	70p
4534	400p
4536	270p
4538	90p
4539	70p
4541	70p
4543	75p
4553	245p
4555	35p
4556	35p
4557	300p
4560	120p
4566	160p
4568	250p
4569	170p
4572	30p
4583	90p
4584	36p
4585	75p
4599	290p
4724	150p
40014	40p
40085	90p
40097	45p
14411	675p
14412	800p
14433	1100p
14495	300p
14500	575p
14599	290p
CD22100	350p
CD22101	700p
CD22102	700p

COUNTERS

74C925	400p
74C928	600p
ICM7216B	2000p
ICM7217A	850p
MK50398N	750p
ZN1040E	670p

TTL & ECL

10116	70p
10231	350p

LINEAR I.Cs

AY1-0212	600p
AY1-5050	99p
AY3-8910	380p
AY3-8912	625p
AY5-4007D	600p
CA3019	80p
CA3028A	120p
CA3046	70p
CA3080E	70p
CA3086	48p
CA3089E	200p
CA3090AQ	375p
CA3130E	90p
CA3140E	40p
CA3160E	100p
CA3161E	150p
CA3162E	450p
CA3189E	300p
DAC1408-8	200p
HA1388	250p
ICL7106	700p
ICL8038	300p
LF351	48p
LF356P	95p
LM10C	325p
LM301A	25p
LM310	120p
LM311	70p
LM318	150p
LM319	215p
LM324	30p
LM339	50p
LM348	65p
LM358P	60p
LM377	175p
LM380	75p
LM381AN	180p
LM386	90p
LM387	120p
LM389	95p
LM393	100p
LM394CH	300p
LM709	36p
LM710	50p
LM711	70p
LM733	60p
LM741	18p
LM747	70p
LM748	35p
LM1886	700p
LM1889	350p
LM2917	200p
LM3900	50p
LM3909	85p
LM3911	125p
LM3914	200p
LM3915	200p
LM3916	225p
LM13600	110p
MB3712	200p
MC1310P	150p
MC1458	36p
MC1495L	350p
MC1496	70p
MC3340P	120p
MC3401	50p
MC3403	65p
MFID	250p
MK50398	750p
ML920	800p
MM57160	620p
NE531	140p
NE555	16p
NE556	45p
NE564	420p
NE565	120p
NE566	155p
NE567	140p
NE571	400p
NE5534A	250p
RC4136	60p
RC4151	200p
S566B	225p
SAA1900	£16
SAD1024A	900p
SFF96364	800p
SL490	350p
SN76477	450p
SP8515	750p
TA7205	90p
TAA550	50p
TAA621	275p
TBA641AX1	300p
TBA641BX1	400p
TBA641B	300p
TBA651	200p
TBA800	80p
TBA810	100p
TBA820	80p
TBA950	225p
TC9109	750p
TCA210	350p
TCA220	350p
TCA940	175p
TDA1004A	300p
TDA1008	320p
TDA1010	200p
TDA1022	500p
TDA1024	120p
TDA1034B	250p
TDA1170	300p
TDA2002V	300p
TDA2020	320p
TLO71/81	25p
TLO72/82	45p
TLO74	100p
TLO83	75p
TLO84	90p
TLO94	200p
TL170	50p
UAA170	170p
ULN2003	108p
XR2206	300p
ZN414	80p
ZN419C	190p
ZN424E	130p
ZN425E	340p
ZN426E	300p
ZN427E	590p
ZN428E	400p
ZN1034E	200p
ZN1040E	670p
ZNA234	850p
ZNA134	£23

CPU's

1802CE	650p
2650A	1200p
6502	350p
6800	225p
6802	250p
6809	650p
INS8060	1100p
8080A	250p
8085A	450p
8088	£18
Z80	290p
Z80A	320p
Z80B	£12
TMS995	£12

SUPPORT DEVICES

3242	800p
6522	310p
6532	550p
6551	650p
6821	100p
6850	110p
6852	250p
8205	225p
8212	110p
8216	100p
8224	200p
8228	220p
8251	250p
8253	390p
8255	250p
8257	400p
8259	400p
8271	£36
8279	440p
Z80P10	250p
Z80AP10	280p
Z80CTC	250p
Z80SIO 1/2/3	£9

MEMORIES

2101-4L	400p
2102-2L	120p
2107B	500p
2111-4L	300p
2112	300p
2114L	90p
2114L-2	95p
4027	300p
4116L-2	90p
4118	400p
4164	400p
4816AP-3	280p
5101L	300p
6116P-3	420p
6116LP-3	550p
6514	200p
6810	120p

PROMS

71301	700p
74S188	275p
74S201	350p
74S287	350p
74S387	350p
74S470	600p
74S471	600p
74S571	650p
74S573	900p
82S123	300p
82S137	750p
93427	400p
93436	650p
93446	650p
93448	900p

BAUD RATE GENERATOR

COM8116	700p
MC14411	675p

EPROMS

2516	250p
2564	£12
2708	250p
2716	250p
2532	375p
2732	450p
2716 300nS	500p
2732 300nS	750p
2764	£11

UARTS

AY-5-1013P	300p
AY-5-1015P	300p
IM6402	450p
TR1602	300p
COM 8017	300p

CHARACTER GEN.

RO-3-2513U.C.	750p
RO-3-2513L.C.	700p
SN74S262AN	£10

CRT CONTROLLER

CRT 5027	£18
CRT 5037	£18
CRT 6545	900p
MC6845	650p
MC6847	£10
SFF96364	£8
9365	£48
EF9366	£48
TMS9927	£18
TMS9928	£20
TM S9929	£20

KEYBOARD ENCODER

AY-5-2376	700p
74C 922N	420p

CRYSTALS

100KHz	250p
200KHz	280p
1MHz	290p
1.008MHz	275p
1.843MHz	210p
2.0MHz	225p
2.457MHz	210p
3.276MHz	150p
3.57945MHz	100p
4.0MHz	150p
4.19MHz	200p
4.43MHz	110p
5.068 MHz	200p
6.0MHz	150p
7.0MHz	150p
8.0MHz	175p
8.867MHz	175p
10.7MHz	150p
15.0MHz	200p
18MHz	200p
24.00 MHz	200p
26.690MHz	150p
27.145MHz	200p

MODULATORS

6MHz UHF	375p
8MHz UHF	450p

TELETEXT DECODER

SAA5020	£6
SAA5030	£9
SAA5041	£16
SAA5050	£9
EF9340	700p
EF9341	700p

INTERFACE ICS

AD558	775p
AD561J	£20
DM8131	275p
DP8304	250p
DS8835	200p
DS8836	150p
DS8838	225p
MC1488	55p
MC1489	55p
MC3446	300p
MC3480	850p
MC3486	500p
MC3487	300p
75107	90p
75110	90p
75150P	120p
75154	140p
75182	90p
75324	375p
75361	150p
75363	150p
75365	150p
75451/2	72p
75491/2	65p
8T26	120p
8T28	120p
8T95/96	90p
8T97/98	90p
9601	220p
9602	220p
9637AP	160p
ZN425E-8	350p
ZN426E-8	350p
ZN427E-8	600p
ZN428E-8	500p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

JUMPER LEADS

24'' Ribbon cable with DIP Headers

	14 pin	16 pin	24 pin	40 pin
Single End	145p	165p	240p	380p
Double End	210p	230p	345p	540p

24'' Ribbon cable with sockets

	20 pin	26 pin	34 pin	40 pin
Single End	160p	210p	270p	340p
Double End	290p	385p	490p	540p

24'' Ribbon cable with edge conn.

	20 way	34 way	40 way	50 way
Single End	275p	525p	600p	650p

24'' Cable with 25 way D Connector
Male 500p Female 540p

EURO CONNECTORS

	Plug	Socket
DIN 41612 2 × 32-way	300p	350p
angled 2 × 32-way	350p	400p
angled 3 × 32-way	400p	—
(for 2 × 32 way specify a + b or a + c)		
DIN 41617 31-way	200p	200p

IDC CONNECTORS

	10 way	20 way	26 way	34 way	40 way
Header Plug	90p	150p	200p	240p	270p
Receptacle	90p	165p	200p	240p	270p
Edge Conn.	200p	250p	320p	380p	560p

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
MALE				
solder	95p	135p	200p	280p
angled	160p	230p	265p	425p
FEMALE				
solder	125p	190p	245p	375p
angled	175p	240p	310p	500p
hood (top/ side entry)	100p	100p	100p	150p

25 way Centronix Type Conn. £6.50
37 way Centronix Type conn. £6.50

VOLTAGE REGULATORS
Fixed Plastic TO-220

1A	+ve		−ve	
5v	7805	40p	7905	45p
6v	7806	40p	7906	45p
8v	7808	40p	7908	45p
12v	7812	40p	7912	45p
15v	7815	40p	7915	45p
18v	7818	40p	7918	45p
24v	7824	40p	7924	45p

100mA +ve		TO-92		
5v	78L05	30p	79L05	50p
12v	78L12	30p	79L12	50p
15v	78L15	50p	79L15	50p

OTHER REGULATORS

LM309K	140p		
LM317T	200p	78MGT2C	140p
LM323K	450p	79GUIC	225p
LM723	30p	79HGKC	650p
78GUIC	200p	78PO5	900p
78HO5	550p	RC4195NB	150p
78HGKC	600p	TL494	300p

OPTO-ELECTRONICS

2N5777	40p	ORP60	120p
OCP71	250p	ORP61	120p
ORP12	90p	TIL78	55p
TIL32	55p		

OPTO-ISOLATORS

ILD74	130p	TIL111	70p
MCT6	160p	TIL112	70p
MOC3020	150p	TIL116	70p
MSC2400	190p		

LEDS

0.125''		0.2''	
TIL220 Red	10p	TIL209 Red	10p
TIL222 Gr	12p	TIL212 Ye	15p
TIL228 Ye	15p	TIL211 Gr	12p
Rectangular		LEDS (R, G, Y)	30p

DISPLAYS

DL 704	140p	NSB5881	570p
DL 707 Red	140p	TIL311	600p
DL 707 Gr	140p	TIL312/3	110p
DL 747 Red	225p	TIL321/2	130p
DL 747 Gr	225p	TIL330	140p
FND357	120p	7750/60	200p
FND500	90p	BARGRAPH	225p
FND507	90p	**DRIVERS**	
MAN3640	200p	9368	250p
MAN4640	200p	9370	300p
MAN6610	200p	UDN6118	320p
		UDN6184	320p

★ SPECIAL OFFER ★

2114L	80p	4116−2	80p
2716 (+5V)	250p	4164−2	450p
2532	350p	6116P−3	350p

TRANSISTORS

BC107/8	14p
BC108/9	15p
BC109/C	16p
BC140	30p
BC141	30p
BC160	30p
BC161	30p
BC177	16p
BC179C	18p
BC182/L	10p
BC183/L	10p
BC184/L	10p
BC212/L	12p
BC213/L	11p
BC214/L	10p
BC327	10p
BC337	10p
BC338	15p
BC477	30p
BC516/7	36p
BC547B	12p
BC548C	9p
BC549C	12p
BC557B	12p
BC558B	12p
BC559C	16p
BCY71/2	20p
BD131	60p
BD132	40p
BD135	40p
BD136	35p
BD139	40p
BD241B	75p
BD242B	75p
BF244B	25p
BF256B	45p
BF257/8	30p
BF259	35p
BF337	30p
BFR80/81	25p
BFY50/51	24p
BFY52	24p
BFY90	75p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJE2955	130p
MJE3055	70p
MPF102	30p
MPF103/4	30p
MPF105	30p
MPSA12	30p
TIP29C	40p
TIP31B	40p
TIP31C	50p
TIP32A/C	75p
TIP32C	50p
TIP33C	70p
TIP35C	150p
TIP36C	160p
TIP41C	55p
TIP42A	50p
TIP42C	60p
TIP47	90p
TIP54	160p
TIP2955	60p
TIP3055	60p
2N2160	295p
2N2219A	25p
2N2222A	25p
2N2484	25p
2N2646	45p
2N2905A	25p
2N3053	25p
2N3054	55p
2N3055	35p
2N3442	140p
2N3702/3	10p
2N3704/5	10p
2N3773	200p
2N3819	20p
2N3820	40p
2N3866	90p
2N3904/6	15p
2N4871	50p
2N5245	40p
2N5457/8	30p
2N5459	30p
2N6027	30p
3N128	120p
3N140/1	120p
40673	75p
40871/2	100p

DIODES

BY127	12p
OA47	9p
OA90	9p
OA91	9p
OA95	9p
OA200	9p
OA202	10p
IN914	4p
IN4148	4p
IN4001/2	5p
IN4003/4	5p
IN4006/7	7p
IN5401/3	14p
IN5404/7	19p
IS920	9p

BRIDGES

1A50V	19p
1A100V	20p
1A600V	30p
2A50V	30p
2A100V	35p
2A400V	45p
3A200V	60p
4A100V	95p
4A400V	100p
6A50V	80p
6A100V	100p
6A400V	120p
8A100V	150p
10A100V	180p
10A400V	200p

SCRS

1A 50V	70p
5A 400V	50p
8A 600V	140p
16A100V	200p
C106D	45p
MCR101	36p
T1C44	36p
2N3525	130p
2N4444	140p
2N5060/4	40p

ZENERS

2.7V-33V

400MW	9p
1W	15p

TRIACS

Plastic

3A 400V	60p
6A 400V	70p
6A 500V	90p
8A 400V	75p
8A 500V	95p
12A500V	105p
16A500V	130p
T 2800D	130p
T1206D	50p
T1226D	70p

RAMS

4116L-20	80p

PCB MOUNTING DIL RELAYS

6vDC 100R coil
SPDT 2A 24v DC
120v AC £1.60

12v DC 400R coil
SPDT 2A 24v DC
120v AC £1.60

12v DC
270R coil
SPDT 10A 24v DC
230v AC £2.25

12v DC
200R coil
DPDT 5A 24v DC
230v AC £2.25

DIL REED RELAYS

5-10v DC coil
0·5A SPDT £2.25

KEYBOARD SWITCHES

Sq. Switch	50p
Digitast	75p
Mini Digitast	75p
Specify Colour	

EXPERIMENTOR BREADBOARDS

Exp 300	£5.75
Exp 325	£3.25
Exp 350	£3.15
Exp 600	£5.25

VALVO HUMIDITY SENSOR	£6.00
BL 30 HR COIL	£1.50
MINI ORGAN IC SAA1900	£16.00

VERO BOARD
(COPPER CLAD)

2.5'' × 5''	90p
2.5'' × 3.75''	80p

MICRO BOARD

Single Eurocard	£3.80
Double Eurocard	£5.25

Vero Wiring Pen	£3.40
Wire Wrapping Tool	£4.70
Veropins (100/pkt)	50p
Spot face cutter	£1.30
Pin Insertion Tool	£1.80

LOGIC PROBE KIT £12

ELEKTERMINAL KIT £50 + 70p p & p

HOUSEKEEPER

Full Kit as described in May Elektor
Sockets for all I.C.'s 2K Prog EPROM
£55 + £1 p & p

Power Supply 1·8A 8V
suitable for the Housekeeper
£7 + £1.10 p & p

JUNIOR COMPUTER KIT **£86** plus **£1** p & p
All Junior Computer Extension Boards available
JUNIOR COMPUTER BOOK: 1 **£4** 2, 3 & 4 **£4.50 ea** (p & p/book **70p**)
TV Games Extension boards available.
ELEKTERMINAL KIT £50 (plus **£1** p & p)
TELETEXT DECODER KIT £85 (plus **£1** p & p).
(Decoding Board and Keyboard Elektor Nov. 81)
Reprint of Teletext articles **£1.25** (plus large SAE)

PROGRAMMED EPROMS

Junior Computer		2 × 2716 Intelekt Chess	ea **£8**
2708 Basic	**£8**	2716 TV Games	**£8**
2716 Tape Management	**£8**	71301 Elekterminal	**£7**
2716 Prog. Management	**£8**	2716 Disco Lights	**£8**
82S23 Interface	**£5**	82S23 Freq. Counter (IC 3C4)	ea **£5**
2716 Housekeeper	**£8**		

PCBs for most Elektor Projects available
SEE OUR FULL PAGE ADVERT IN THIS ISSUE FOR DETAILS ON BBC COMPUTER, PRINTERS etc.

TECHNOMATIC LTD

MAIL ORDERS TO: 17 BURNLEY ROAD, LONDON NW10 1ED
SHOPS AT: 17 BURNLEY ROAD, LONDON NW10
(Tel: 01-452 1500, 01-450 6597. Telex: 922800)
05 EDGWARE ROAD, LONDON W2

PLEASE ADD 40p p&p & 15% VAT
(Export: no VAT, p&p at Cost)
Orders from Government Depts. & Colleges etc. welcome.
Detailed Price List on request.
Stock items are normally by return of post.

contents

selektor 12-17

coming soon? 12-19
There is something fascinating about predictions. Journalism in general and magazine editors in particular love to look into a crystal ball at the beginning of every year. This article is one of those . . .

milliohmmeter 12-24
A more precise method to measure the resistances of loudspeakers, coils, conductors (printed circuit board copper tracks) and the like. The lowest measuring range is 0.5 Ω ± 1% (full scale deflection), which really gives us something to work with.

the accessories for the Crescendo power amplifier 12-28
The second part of the XL system, containing the protection circuits for the Crescendo power amplifiers. The d.c. detection and power-up circuits in this article are a must for any good quality power amplifier.

darkroom computer tips 12-33
with contributions from H. Fietta.
As a result of the many enquiries received from readers, we describe the manner in which our darkroom computer can be connected to the well known Philips enlargers; PCS 2000 and PCS 130/150. A new method of obtaining better linearity of the thermometer is also shown.

chips for digital audio 12-36
So far digital audio has restricted itself to the studios. But, let's face it: there is no doubt that it will soon be in the living room. Before going out and throwing away your existing system it is better to find out a little about this new development.

3 A computer supply 12-43
This 5 V/3 A power supply is ideal for powering additional memories, peripheral equipment and the like. Internal protective circuits against excessive load currents and temperature rise ensure that the power supply can survive considerable mistreatment.

traffic-light control system 12-46
D. Herzberg.
Apply the Junior for a classical task; a control function which can otherwise only be implemented with considerable amounts of hardware.

technical answers 12-48
The home telephone help article last month started our new section. This month we continue with further useful hints, ideas and tips.

ejektor 12-50
from an idea of E. Muller.
An invitation to investigate, improve and implement imperfect but interesting ideas: the 'Fourier' synthesis.

tomorrow's music 12-53
Factors affecting the change in 'hi-fi' techniques are: the market, current and future legislation and last, but, not least, the electronic components industry. The article takes a look at 'hi-fi' up to the end of the century.

upper and lower case on the Elekterminal 12-56
D. Paulsen.
The ELEKTERMINAL becomes an elekterminal. Continuing with the series of extensions, lower case and special characters are introduced.

market 12-60

switchboard 12-61

EPS service 12-72

advertisers index 12-74

elektor
93
January 1983
75p.
up-to-date electronics for lab and leisure

countdown and d.c. protection for the CRESCENDO · 3A computer supply · mate the darkroom computer to the PCS 2000 · improve your connections with a milli-ohmmeter · digital audio - a giant step, or a small leap?

Here we are; 1983! A continuation of projects started during last year, new ones to wet the appetite for the coming months and certain subtle changes to the look of our inside pages. These changes which could be termed as our winter clean look very nice to us, but it would be very much appreciated if readers could supply their views. Next time you send us a technical question, why not include your comments?

WATFORD ELECTRONICS

34/35 CARDIFF ROAD, WATFORD, HERTS, ENGLAND
MAIL ORDER, CALLERS WELCOME
Tel. Watford (0923) 40588. Telex: 8956095

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.Os OR BANKERS DRAFT WITH ORDER OR ACCESS. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT ENQUIRY WELCOME. P&P ADD 50p TO ALL CASH ORDERS. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE. ACCESS ORDERS WELCOME.

VAT Export orders no VAT. Applicable to U.K. Customers only. Unless stated otherwise, all prices are exclusive of VAT. Please add 15% tot he total cost including P&P.
We stock thousands more items. It pays to visit us. We are situated behind Watford Football Ground.
Nearest Underground/BR Station: Watford High Street.
Open Monday to Saturday: 9.00am to 6.00pm. Ample Free Car Parking space available.

ELECTROLYTIC CAPACITORS: (Values in uF) **500v**: 10uF **52p**; 47 **78p**; 63V: 0.47, 1.0, 1.5, 2.2, 3.3, 4.7 **8p**; 10 **10p**; 15, 22 **12p**; 33 **15p**; 47 **12p**; 68 **20p**; 100 **19p**; 220 **26p**; 1000 **70p**; 2200 **99p**; **50V**: 68 **20p**; 100 **17p**; 220 **24p**; **40V**: 6.8 **15p**; 22 **9p**; 33 **12p**; 330, 470 **32p**; 1000 **48p**; 2200 **90p**; **25V**: 1.5, 4.7, 10, 22, 47 **8p**; 100 **11p**; 150 **12p**; 220 **15p**; 330 **22p**; 470 **25p**; 680, 1000 **34p**; 1500 **42p**; 2200 **50p**; 2200 **50p**; 3300 **76p**; 4700 **92p**; **16V**:
47, 68, 100 **9p**; 125 **12p**; 330 **16p**; 470 **20p**; 680 **34p**; 1000 **27p**; 1500 **31p**; 2200 **36p**; 4700 **79p**.

TAG-END CAPACITORS: **64V**: 2200 **139p**; 3300 **198p**; 4700 **245p**; **50V**: 2200 **110p**; 3300 **154p**; **40V**: 4700 **160p**; **25V**: 2200 **90p**; 3300 **98p**; 4000, 4700 **98p**; 10,000 **320p**; 15,000 **345p**; **16V**: 22,000 **360p**

POLYESTER CAPACITORS: Axial Lead Type
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 **11p**; 10n, 15n, 18n, 22n **12p**; 33n, 47n, 68n **16p**; 150n **20p**; 220n **30p**; 330n **42p**; 470n **52p**; 680n 1uF **68p**; 2u2 **82p**.
160V: 10nF, 12n, 39n, 100n **11p**; 150n, 220n **17p**; 330n, 470n **30p**; 680n **38p**; 1uF **42p**; 1u5 **45p**; 2u2 **48p**; 4u7 **58p**.
1000V: 1nF **17p**; 10nF **30p**; 15n **40p**; 22n **36p**; 33n **42p**; 47n, 100n **42p**.

SIEMENS pcb Type Miniature poly Capacitors
250V

1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n	7p
18n, 22n, 27n, 33n, 39n, 47n	8p
39n, 56n	12p
82n, 100n	11p
100V	
100n, 120n	10p
150n, 180n	12p
220n, 270n	15p
330n, 390n	20p
470n, 560n	26p
680n	30p
1uF **34p** 2u2	50p

POLYESTER RADIAL LEAD CAPACITORS: **250V**
10n, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **7p**; 150n, 220n **10p**; 330n, 470n **13p**; 680n **19p**; 1u **23p**; 1u5 **40p**; 2u2 **46p**.

FEED-THROUGH CAPACITORS
1000pF/450V **8p**

TANTALUM BEAD CAPACITORS
35V: 0.1uF, 0-22, 0-33 **15p**; 0-47, 0-68, 1-0, 1.5 **16p**; 2.2, 3-3 **18p**; 4.7, 6.8 **22p**; 10 **28p**; **16V**: 2.2, 3.3 **16p**; 4.7, 6.8, 10 **18p**; 15, **36p**; 22 **30p**; 33, 47 **40p**; 100 **75p**; **10V**: 15, 22, **26p**; 33, 47 **35p**; 100 **55p**; **6V**: 100 **42p**.

POTENTIOMETERS: Rotary, Carbon, Track 0.25W Log & Lin values.

500Ω, 1KΩ & 2KΩ (Linear only) Single Gang.	30p
5KΩ-2MΩ Single Gang Log & Lin	30p
5KΩ-2MΩ Single Gang D/P Switch	78p
5KΩ-2MΩ Double Gang	89p

MYLAR FILM CAPACITORS
100V: 1nF, 2, 4, 4nF, 10 **6p**; 15nF, 22n, 30n, 40n, 47n **7p**; 56n, 100n, 200n **9p**; **50V**: 470nF **12p**.

SLIDER POTENTIOMETERS
0-25W log and linear values 60mm

5KΩ-500KΩ single gang	70p
10KΩ-500KΩ dual gang	110p
Self Stick Graduated Bezel	40p

CERAMIC CAPACITORS 50V:
Range: 0-5pF to 10nF **4p**. 15nF; 22nF, 33nF; 47nF **5p**. 100nF/30V **7p**. 200nF/6V **8p**.

PRESET POTENTIOMETERS
0.1W 50Ω 5MΩ Miniature

Vertical & Horizontal	7p
0-25W 100Ω 3-3MΩ horiz. larger	10p
0-25W 200Ω 4-7MΩ vert.	10p

ACCESS
Orders
Just phone your orders through. We do the rest.
0923 50234

POLYSTYRENE CAPACITORS:
10pF to 1nF **8p**; 1.5nF to 12nF **10p**

SILVER MICA (Values in pF)

2, 3-3, 4.7, 6.8, 8.2, 10, 12, 15, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180pF	15p each
200, 220, 250, 270, 300, 330, 360, 390, 470, 800, 800, 820	21p each
1000, 1200, 1800, 2200	30p each
3300, 4700pF	60p each

MINIATURE TRIMMERS Capacitors
2-6pF, 2-10pF **22p**; 2-25pF, 5-60pF **30p**; 10-88pF **36p**.

RAM FOR BBC MICRO
4816AP
100ns
225p

RESISTORS Carbon Film Hi-Stab. 5%, miniature

	RANGE	Val	1-99	100 +
¼W	2Ω2-4M7	E24	2p	1p
½W	2Ω2-4M7	E12	2p	1p
1W	2Ω2-4M7	E12	5p	4p
2% Metal Film		E24	6p	4p
1% Metal Film		E24	8p	6p

100 + price applies to Resistors of each type not mixed.

RESISTORS Network S.I.L.
7 Commoned: (8 pins) 100Ω, 680Ω, 1K 2k2, 4K7, 10K, 47K 100K **25p**
8 Commoned: (9 pins) 150Ω, 180Ω, 270Ω, 330Ω, 1K, 2k2, 4K7, 10K, 22K, 47K & 100K **26p**.

DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	12
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

NOISE Diode

Z5J	195p

VARICAPS

BA102	50
BB105B	40
BB106	40
109B	45
2	165

BRIDGE RECTIFIERS

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56
VM18 DIL	50

ZENERS

Range: 2V7 to 39V 400mW **8p each**
Range: 3V3 to 33V. 1.3W **15p each**

TRIACS

3A 200V	54
3A 400V	56
8A 100V	60
8A 400V	69
8A 800V	115
12A 100V	78
12A 400V	82
12A 800V	135
16A 100V	103
16A 400V	105
16A 800V	220
25V 500V	220
25A 800V	295
T2800D	120

75 SERIES

75107/8	95
75110	90
75114/5	150
75121/2	130
75150	125
75154	150
75182/3	99
75188/9	55
75322	140
75324	360
75361/3	150
75365	150
75450	86
75451/2	52
75454	85
75491/2	65

SCR THYRISTORS

5A/40V	32
5A 400V	40
5A 600V	48
8A 300V	60
8A 600V	90
12A 100V	78
12A 400V	95
12A 800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

DIAC

ST2	25

COMPUTER ICs

1702	350
1802CP	650
2114L-300n	90
2114L-200n	95
2147	425
2532-450n	350
2564	£12
2708	225
2716-5V	215
2732-450n	350
2764	999
3242	590
4816-100nS	225
4027	190
4116-150n	85
4116-200n	80
4118-250	325
4164-200n	500
4334-3 = CMOS 2114-3	325
4816-100nS	225
4864-364K	500
5101-450	220
6116-150nS	390
6116L 120	550
6117-100n	490
6502CPU	325
6503	600
6504 250	550
6505	600
6520PIA	100
6521	100
6522VIA	300
6530	£11
6352RRIOT	570
6545RTC	899
6551ACIA	650
6592PC	£20
6800	225
6802	250
6803	850
6804	160
6805	670
6808	520
6809	630
6810	115
6820	100
6821	100
68B21	220
6840	375
6843	£12
6845	685
6847	650
6850	110
6852	250
6854	599
6875	500
68000	£78
74C922	420
8080A	250
8085A	350
8088	£18
8118-10	225
8123	125
8155	350
8156	350
81LS95	80
81LS96	80
81LS97	80
81LS98	85
8202	£25
8205	225
8212	110
8214	425
8215	300
8216	100
8224	110
8225	£11
8226	250
8228	220
8243	270
8250	850
8251A	250
8253	400
8255	225
8256AC	£35
8257-5	400
8259	395
8271	£36
8279	385
8284	350
8288	£10
8P8304BN	250
8T26A	99
8T27	150
8T28A	120
8T31	350
8T95	90
8T97N	90
9364AP	550
9602	220
AM26LS31C	125
AM26LS32A	125
AY-3-1015	300
AY-5-1350	388
AY-5-2376	600
AY-5-2376	600
COM8017	275
COM8116	700
DM8131	275
DS3691N	320
DS88LS120N	275
FD1771	£15
FD1791	£22
FD1793	£23
FD1795	£28
FD1799	£28
FD1797	£28
HD26501	75
IM6402	380
INS8060N	1050
INS8154N	£9
MC1488	55
MC1489	55
MC14411	690
MC14412	790
MC3446	250
MC3447P	315
MK3886-2M	£7
MM1702A	300
MM5280D	695
MM5303	635
MM5307	1275
MM5387A	475
MM58174	770
MM74C922	420
RO-3-2513L	650
RO-3-2513U	650
SFF9634E	800
TMS2716-3V	725
TMS6011	365
TMS9928	£30
ULN2003	90
UPD7002	440
Z80CPU 2.5	299
Z80ACPU 4M	300
Z80 CTC	250
Z80A CTC	260
Z80B	£11
Z80 DART	495
Z80A DART	550
Z80 DMA	675
Z80 DART	698
Z80 PIO	260
Z80A PIO	275
Z80 SIO-1	850
Z80A DIO	980

LINEAR ICs

555CMOS	80
702	75
709C 8 pin	35
710	48
741 8 pin	14
747C 14 pin	65
748C 8 pin	36
753 8 pin	185
810	159
9400CJ	350
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-1-6720	210
AY-3-1270	730
AY-3-1350	350
AY-3-8910	438
Booklet for AY-3-8910	150
AY-3-8912	625
AY-5-1230	450
AY-5-1317A	630
AY-5-1350	388
CA3011	130
CA3012	175
CA3014	275
CA3018	86
CA3019	80
CA3020	210
CA3023	210
CA3028A	95
CA3035	255
CA3036	270
CA3043	275
CA3045	365
CA3046	70
CA3048	220
CA3059	285
CA3075	213
CA3080E	70
CA3081	190
CA3086	48
CA3089E	215
CA3090AQ	375
CA3123E	165
CA3130	90
CA3140	40
CA3160	95
CA3161	160
CA3162E	450
CA3189	200
HA1336W	240
HA1388	255
ICL7106	750
ICL7107	975
ICL7611	99
ICL7660	190
ICL8038CC	300
ICL8211A	150
ICM7205A	1150
ICM7207	475
ICM7215	1050
ICM7216AJ	1950
ICM7216B	1950
ICM7216C	1950
ICM7217A	790
ICM7224	785
ICM7240	300
ICM7555	80
ICM7556	150
LA3350	250
LA4031P	340
LA4032	295
LA4400	440
LC7130	340
LC7120	300
LC7137	396
LF347	150
LF351	48
LF353	95
LF355	85
LF356	95
LF357	110
LF398	475
LM10	325
LM301AO	24
LM307	45
LM308T	95
LM311	70
LM318N	150
LM319	215
LM324A	30
LM334Z	90
LM335Z	128
LM339	47
LM348	64
LM349	115
LM358	60
LM377	175
LM379	480
LM380	75
LM381N	145
LM382	115
LM384	140
LM386	90
LM387	120
LM389	95
LM393	100
LM558	75
LM725CN	325
LM733	70
LM1458	45
LM1871	325
LM2917	195
LM301	24
LM307	45
LM3302	75
LM3900	50
LM3909N	85
LM3911	125
LM3914	250
LM3915	250
LM3916	250
LM13600	110
LS7220	280
M252AA	625
M253AA	1150
M51513L	230
M51515L	320
M51516L	475
MB3712	220
MB3756	440
MC1204	250
MC1301	79
MC1303	88
MC1304P	260
MC1310P	150
MC1445	250
MC145106	695
MC1458	35
MC1469	300
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	90
MC3340P	120
MC3360P	120
MC3401	65
MC3403	75
MC3405	150
MC3423	180
MC4016	00
MFC6040	75
MK50398	635
ML924	275
MSM5526	820
NE515	275
NE529	225
NE531	140
NE534	150
NE543K	225
NE544	210
NE555	16
NE556	45
NE560	325
NE561	398
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567V	140
NE570	410
NE571	400
NE5534A	150
OM335	750
RC4136D	69
RC4558	45
S566B	225
SAB3209	425
SAB3210	325
SAB3271	485
SAB4209	595
SG3402	295
SL490	350
SN76003N	350
SN76013	350
SN76018	148
SN76023N	350
SN76023ND	240
SN76033N	350
SN76115N	215
SN76131	125
SN76227N	95
SN76477	420
SN76488	480
SN76660	120
SP8629	299
TA7210	150
TA7204	200
TA7205	90
TA7205A	225
TA7222	150
TA7310	160
TAA621AX1	295
TAA661A	190
TAA700	275
TAA900	395
TAD100	159
TBA120S	70
TBA540Q	275
TBA550Q	330
TBA641BX or BX11	290
TBA651	190
TBA800	80
TBA810	95
TBA820	80
TBA920Q	200
TBA950	300
TBA990Q	350
TBA540	275
TCA220	350
TCA270Q	350
TCA280A	220
TCA940	175
TCA965	120
TDA1004	290
TDA1008	310
TDA1010	198
TDA1022	499
TDA1024	115
TDA1034	350
TDA1490	325
TDA2002	325
TDA2004	495
TDA2020	320
TDA2030	295
TDB0701	420
TL170	50
TL061CP	40
TL062CP	60
TLO64CN	98
TLO71CP	24
TLO72CP	45
TLO74CN	100
TLO81CP	24
TLO82CP	45
TLO83CP	75
TLO84CN	90
TLO91CP	55
UA2240	120
UA78540	230
UAA170	170
UAA180	170
UAA1003-3	935
ULN2003	85
ULN2004	90
ULN2283	100
UPC575	350
UPC1025H	375
UPC1182	330
UPC1156H	290
UPC1366	195
XR2206	300
XR2207	375
XR2211	575
XR2216	675
XR2266	360
ZN414	80
ZN419E	190
ZN423E	135
ZN424E	130
ZN425E	345
ZN426E	300
ZN427E	600
ZN428E	410
ZN429E	210
ZN459	570
ZN1034E	200
ZN1040E	675
ZNA234E	850

TRANSISTORS

AC125	36
AC126/7	36
AC128	30
AC141/2	30
AC176	28
AC187	32
AC188	32
ACY17/18	70
ACY19/20	75
ACY21/22	75
ACY28	75
ACY39/41	86
AD142	120
AD142	120
AD149	79
AD161	42
AD162	42
AF115/6	60
AF117/8	90
AF124/26	70
AF139	40
AF178	75
AF186	70
AF239	56
ASZ21	125
BC107	10
BC107B	12
BC108	10
BC108B	12
BC109	10
BC109B	12
BC109C	12
BC114/5	22
BC117/8	20
BC119	38
BC137/9	40
BC140	30
BC142/3	30
BC147	9
BC147B	10
BC148	9
BC148B	10
BC149	9
BC149C	10
BC153/4	27
BC157/8	10
BC159	11
BC160	45
BC167A	10
BC168C	10
BC169C	10
BC170	15
BC171/2	11
BC173	11
BC177/8	16
BC179	20
BC181	20
BC182/3	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC186/7	26
BC212	10
BC212L	10
BC213	10
BC213L	10
BC214	10
BC214L	10
BC237/8	14
BC307B	14
BC308	16
BC327/8	15
BC337/8	15
BC441/61	34
BC477	40
BC516/7	40
BC547/8	12
BC549C	14
BC556/7	15
BC558/9	15
BCY30	68
BCY34	85
BCY35	50
BCY39/40	85
BCY41/42	14
BCY45	50
BCY58/59	35
BCY70/71	16
BCY72	20
BCY78	24
BD112	125
BD121	95
BD124	115
BD131/32	48
BD133	70
BD135	45
BD136/37	40
BD138/39	40
BD140	40
BD144/45	198
BD158	55
BD205/6	110
BD222	85
BD245	45
BD378	70
BD434	55
BD517	75
BD695A	125
BD696A	125
BDY56	180
BDY60	160
BF115	35
BF154/8	25
BF167	29
BF173	27
BF177	25
BF178	30
BF179	35
BF180/2	38
BF184/5	38
BF194/5	12
BF196/7	12
BF198/9	18
BF200	80
BF224A	25
BF224B	29
BF245	30
BF256A	35
BF256B	45
BF257/8	32
BF259	35
BF274	42
BF336/7	40
BF451	35
BF594/5	30
BFR39/40	23
BFR41/79	23
BFR80/81	25
BFR98	105
BFX29	28
BFX81	45
BFX84	28
BFX85/6	28
BFY18	50
BFY50/51	23
BFY52	23
BFY53	32
BFY55/6	32
BFY64	35
BFY81	120
BFY90	80
BRY39	40
BSX20	20
BSX26/29	34
BSX78	45
BSY26	30
BSY95A	25
BU105	170
BU205	190
BU206	200
BU208	200
BUY69C	225
E421	250
MD8001	250
MJ490	90
MJ491	175
MJ2955	70
MJE170	150
MJE180	150
MJE340	54
MJE370	100
MJE371	100
MJE520	95
MJE521	95
MJE2955	99
MJE3055	70
MPF102	40
MPF103	30
MPF104	30
MPF105	30
MPF106	40
MPSA05	25
MPSA08	25
MPSA12	32
MPSA55	30
MPSA56	30
MPSU02	58
MPSU05	55
MPSU06	55
MPSU52	65
MPSU56	60
MPSU56	60
MPU131	52
OC26	170
OC28/35	220
OC36/41	75
OC42/44	75
OC45/70	40
OC71/72	40
OC74/75	50
OC76/77	50
OC81/82	50
OC83/84	40
OC170/71	50
OC200	50
TIP29A	32
TIP29C	38
TIP30A	35
TIP30C	37
TIP31A	38
TIP31B	39
TIP31C	39
TIP32A	38
TIP32C	42
TIP33A	65
TIP33C	78
TIP34A	74
TIP34C	88
TIP35A	110
TIP35C	128
TIP36A	130
TIP36C	140
TIP41A	50
TIP41B	52
TIP42A	55
TIP42B	58
TIP120	70
TIP121/2	73
TIP141/2	105
TIP147	120
TIP2955	60
TIP3055	60
TIS43	32
TIS44/5	45
TIS46	45
TIS48	50
TIS59/74	50
TIS88A	50
TIS90/91	30
UC734	65
VK101	80
VN10KM	55
VN46AF	78
VN66AF	80
VN88AF	94
VN89AF	96
ZTX107/8	11
ZTX109	12
ZTX212	28
ZTX300	13
ZTX301	16
ZTX302	16
ZTX303	25
ZTX304	17
ZTX314	25
ZTX326	30
ZTX341	30
ZTX451	23
ZTX500	14
ZTX501/2	15
ZTX503	18
ZTX504	25
ZTX531	25
ZTX550	25
2N697	23
2N698	40
2N699	48
2N706A	19
2N708	19
2N918	35
2N1131/2	24
2N1302	45
2N1303	65
2N1304/5	60
2N1306/7	65
2N1308	68
2N1613	30
2N1670	150
2N1671B	160
2N2160	296
2N2217	45
2N2218A	25
2N2219A	28
2N2220A	26
2N2221A	26
2N2222A	25
2N2297	25
2N2303	45
2N2368	25
2N2369A	18
2N2476	50
2N2483/4	27
2N2646	45
2N846	80
2N2904/5	26
2N2906/7	26
2N2907A	26
2N2926G	10
2N3011	28
2N3053	26
2N3054	58
2N3055	48
2N3108	45
2N3252	46
2N3302	30
2N3441/2	140
2N3614/5	199
2N3663	15
2N3702/3	10
2N3704/5	10
2N3706/7	10
2N3708/9	10
2N3710/11	10
2N3713	140
2N3771	179
2N3772	195
2N3773	210
2N3819	22
2N3820	38
2N3822/3	45
2N3824	65
2N3866	90
2N3870	150
2N3903/4	15
2N3905/6	15
2N3906	17
2N4037	46
2N4041	40
2N4058	10
2N4061/2	10
2N4064	115
2N4069	45
2N4220	78
2N4234/6	48
2N4264	24
2N4286	15
2N4289	18
2N4314	78
2N4400	18
2N4427	80
2N4859	78
2N4871	55
2N4898	135
2N4901	175
2N4921	55
2N4922	70
2N5135/6	20
2N5138	18
2N5172	18
2N5179	45
2N5180	45
2N5190/1	75
2N5194	80
2N5305/8	30
2N5457/8	30
2N5459	30
2N5485	36
2N5777	45
2N5879	190
2N6027	32
2SA671	250
2SA715	60
2SC495	70
2SC496	70
2SC1061	250
2SC1096	85
2SC1162	30
2SC1173	125
2SC1306	100
2SC1307	150
2SC1449	85
2SC1678	140
2SC1679	190
2SC1923	50
2SC1945	225
2SC1963	90
2SC1957	90
2SC1969	140
2SC2028	85
2SC2029	210
2SC2078	170
2SC2091	85
2SC2314	85
2SC2166	165
2SC2335	225
2SC2547	30
2SC2612	225
2SD234	74
2SK45	90
2SK288	225
2SJ83	225
2SJ85	225
3N128	112
3N140	112
40097	120
40250	95
40311	60
40313	130
40315	90
40316	95
40317/20	80
40323	60
40324	100
40326/7	70
40347	90
40348	120
40360	60
40361/2	70
40407/8	75
40411	285
40412	90
40467A	130
40468	85
40594	106
40603	110
40673	75
40871/2	90

RF CHOKES Miniature PCB type

1uH, 2u2, 4u7, 10u, 22u, 33u, 47u, 100u, 220u, 330u, 470u	30p
1mH, 1m5, 2m2, 4m7, 10mH	35p
22m, 33m, 43m	60p
100m	75p

TTL74

7400	11
7401	11
7402	11
7403	12
7404	13
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14
7411	16
7412	18
7413	18
7414	24
7416	20
7417	20
7420	15
7421	20
7422	20
7423	20
7425	18
7426	18
7427	15
7428	26
7430	14
7432	22
7433	22
7437	25
7438	22
7440	15
7441	55
7442	32
7443	90
7444	90
7445	55
7446	60
7447	40
7448	45
7450	16
7451	16
7453	16
7454	16
7460	16
7470	35
7472	24
7473	26
7474	20
7475	25
7476	25
7480	48
7481	120
7482	65
7483	38
7484	70
7485	60
7486	20
7489	170
7490	20
7491	35
7492	25
7493	25
7494	35
7495	35
7496	35
7497	90
74100	80
74104	50
74105	55
74107	20
74109	25
74110	35
74111	55
74112	170
74116	50
74118	55
74119	60
74120	60
74121	25
74122	35
74123	35
74125	35
74126	35
74128	35
74132	30
74136	28
74141	55
74142	175
74143	210
74144	210
74145	50
74147	75
74148	60
74150	50
74151	40
74153	40
74154	55
74155	40
74156	40
74157	30
74159	80
74160	60
74161	48
74162	40
74163	40
74164	40
74165	48
74166	48
74167	150
74170	125
74172	250
74173	60
74174	54
74175	55
74176	40
74177	45
74178	80
74179	80
74180	40
74181	115
74182	60
74184	90
74185	95
74186	470
74188	250
74190	48
74191	46
74192	46
74193	45
74194	40
74195	40
74196	46
74197	40
74198	80
74199	84
74221	54
74246	120
74247	120
74248	120
74249	120
74251	65
74259	150
74265	55
74273	150
74276	120
74278	100
74279	50
74283	50
74284	155
74285	155
74290	105
74293	80
74297	236
74298	100
74351	195
74365	30
74366	30
74367	30
74368	30
74390	75
74393	90
74490	95

74C

74C244	195
74C245	195
74C373	240
74C374	245
74C922	420

74L

74L00	68
74L04	85
74L30	50
74L47	380
74L75	145
74L85	349
74L121	165
74L123	325

74S

74S00	38
S02	30
S03	30
S04	40
S05	60
S08	60
S20	40
S32	70
S74	75
S86	85
S112	85
S114	85
S132	110
S133	60
S138	180
S157	250
S158	210
S188	210
S189	158
S194	320
S195	795
S201	320
S225	510
S241	390
S251	70
S257	250
S262	850
S287	300
S288	210
S289	195
S301	350
S412	380
S470	325
S471	620
S472	1150
S475	825
S571	620

74LS

LS00	11
LS01	11
LS02	11
LS03	12
LS04	12
LS05	13
LS08	12
LS09	12
LS10	13
LS11	13
LS12	13
LS13	20
LS14	26
LS15	13
LS20	13
LS21	13
LS22	13
LS26	14
LS27	13
LS28	14
LS30	13
LS32	13
LS33	15
LS37	15
LS38	15
LS40	13
LS42	28
LS47	35
LS48	45
LS49	50
LS51	14
LS54	14
LS55	14
LS63	120
LS73	18
LS74	18
LS75	20
LS76	18
LS78	18
LS83	36
LS85	42
LS86	16
LS90	28
LS91	60
LS92	32
LS93	26
LS95	40
LS96	95
LS107	40
LS109	28
LS112	26
LS113	22
LS114	22
LS122	36
LS123	36
LS124	90
LS125	24
LS126	25
LS132	35
LS133	30
LS136	24
LS138	25
LS139	32
LS145	70
LS147	100
LS148	70
LS151	40
LS153	40
LS155	35
LS156	36
LS157	27
LS158	30
LS160	32
LS161	35
LS162	35
LS163	35
LS164	40
LS165	50
LS166	65
LS168	84
LS170	75
LS173	65
LS174	50
LS175	45
LS181	90
LS183	180
LS190	45
LS191	45
LS192	45
LS193	45
LS194	35
LS195	35
LS196	45
LS197	45
LS200	27
LS202	27
LS221	5
LS240	6
LS241	6
LS242	6
LS243	6
LS244	5
LS245	7
LS247	5
LS248	5
LS249	5
LS251	3
LS253	3
LS257	3
LS258	3
LS259	5
LS260	2
LS261	10
LS266	2
LS273	5
LS275	12
LS279	3
LS280	
LS283	
LS290	
LS293	
LS295	
LS298	
LS299	1
LS300	1
LS302	1
LS320	2
LS323	1
LS324	1
LS325	2
LS326	2
LS327	2
LS347	
LS348	
LS352	
LS353	

SWITCHES

TOGGLE 2A, 250V

SPST	33p
DPDT	44p

SUB-MIN TOGGLE

SPST on/off	54p
SPDT c/over	60p
SPDT centre off	85p
SPDT biased both ways	105p
DPDT 6 tags	75p
DPDT centre off	88p
DPDT biased both ways	145p
DPDT 3 positions on/on/on	185p
3-pole 2 way	205p

SLIDE 250V:

DPDT 1A	14p
DPDT 1A c/off	15p
DPDT ½A	13p

PUSHBUTTON 6A
with 10mm Button

SPDT latching	99p
DPDT latching	145p
SPDT moment	99p
DPDT moment	145p

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIL SWITCHES
(SPST) 4 way **70p**; 6 way **85p**; 8 way **90p**; 10 way **145p**.
(SPDT) 4 way **190p**.

ROTARY SWITCHES:
(Adjustable Stop type)
1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4p/2 to 3 way **45p**

ROTARY: Mains DP 250V 4 Amp on/off **56p**

ROTARY: (Mak-a-switch)
Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max 6 pole/12 way - DP switch)
Mechanism only **90p**

WAFERS: (make before break) to fit the above switch mechanism
1 pole/12 way, 2 pole/6 way, 3 pole/4 way; 4 pole/3 way; 6-/2 way **65p**
Mains DP 4A Switch to fit **45p**
Spacers **4p**. Screen **6p**

ROCKER: 5A/250V SPST	28p
ROCKER: 10A/250V SPDT	38p
ROCKER: 10A/250V DPDT c/off	95p
ROCKER: 10A/250V DPST with neon	85p

THUMBWHEEL Mini front mounting

Decade Switch Module	220p
B.C.D. Switch Module	275p
Mounting Cheeks (per pair)	75p

VEROBOARD 0.1in

	clad	plain
2½ · 3¼	80p	
2½ · 5	91p	–
3¾ · 3¾	91p	–
3¾ · 5	105p	87p
3¾ · 17	360p	232p
4¾ · 17	470p	–
Pkt of 100 pins		50p
Spot face cutter		135p
Pin insertion tool		178p

VQ Board	180
DIP Board	350
Vero Strip	374

PROTO DECs

Veroblock	405p
S-Dec	350p
Eurobreadboard	520p
Bimboard 1	575p
Superstrip SS2	1350p

VERO WIRING PEN + spoool 340p
Spare spool 75p
Combs 6p

DALO ETCH RESIST PEN
Plus spare tip 90p

FERRIC CHLORIDE
1 lb bag Anhydrous
195p · 50p P&P

ULTRASONIC TRANSDUCER
40KHz 325 pr

COPPER CLAD BOARDS

Fibre glass	Single sided	Double sided	SRBP 9.5 · 8.5
6 · 6	90p	110p	95p
6 · 12	150p	195p	

DIL SOCKETS

	Low Prof	Wire Wrap
8pin	8p	25p
14pin	10p	35p
16pin	10p	42p
18pin	16p	52p
20pin	20p	60p
22pin	22p	65p
24pin	25p	70p
28pin	28p	80p
40pin	30p	99p

EDGE CONNECTORS

	.1	.156
2 × 15 way	–	140p
2 × 18 way	180p	145p
2 × 22 way	199p	200p
2 × 23 way	190p	–
2 × 25 way	225p	220p
2 × 28 way	210p	–
2 × 30 way	245p	–
2 × 36 way	295p	–
2 × 40 way	315p	–
2 × 43 way	395p	–
2 × 75 way	550p	–

IDC CONNECTORS

	PCB Plugs with latch Pins Strt	pins Angle	Female Header Plug
10 way	90p	99p	85p
16 way	130p	150p	110p
20 way	145p	166p	125p
26 way	175p	200p	150p
34 way	205p	236p	169p
40 way	220p	250p	190p
50 way	235p	270p	200p
60 way	–	–	230p

EURO CONNECTORS

	Female Socket Strt Pins	Female Socket Angle Pins	Male Plug Strt Pins	Male Plug Angle Pins
DIN41617 31way	170p	–	–	175p
DIN41612 2 × 32 A - B	285p	325p	220p	295p
DIN41612 2 × 32 A - C	300p	340p	240p	300p
DIN41612 3 × 32 A - B - C	360p	385p	260p	400p

DIL PLUG (Header)

	Solder	IDC
14pin	40p	99p
16pin	49p	105p
24pin	88p	178p
40pin	250p	255p

RIBBON CABLE
price per foot

	Grey	Color
10 way	12p	22p
16 way	18p	32p
20 way	25p	40p
24 way	35p	50p
34 way	48p	60p
40 way	55p	75p
50 way	65p	90p
64 way	85p	110p

ZIF DIL SOCKETS

24 pin	575p
28 pin	820
40 pin	975p

PANEL METERS

FSD
60 × 46 × 35mm
0-50μA
0-100μA
0-500μA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"
495p each

RELAYS

Miniature, enclosed, PCB moun
Our RL6 series
SPCO
RL6-91 170Ω coil, 7V5 to 12V DC, 380V/6A AC, 1300VA/50W **210p**
DPCO
43Ω coil, 4V2-7V DC, 250V AC, 5A, 1100VA/150W **218p**
RL6-111 170Ω coil, 8V-14V, 250V AC 5A **220p**
RL6-114 740Ω coil, 17V5-29V 250V 5A AC **222p**

AMPHENOL PLUGS

IEEE 24 Way	550
Centronics Parallel 36 Way solder	530
Centronic Parallel 36 way IDC	550

BUZZERS, miniature, solid-state 6V, 9V & 12V **70p**

PIEZOI TRANSDUCERS
PB2720 **55p**

LOUDSPEAKERS
Miniature, 0.3W: 8Ω
2in, 3¼in, 2½in, 3in 80p
2½in 40Ω, 64Ω or 80Ω 80p

ASTEC UHF MODULATORS

Standard 6MHz	280p
Wideband 8MHz	425p

ELEKTOR PROJECTS
We stock most of the parts

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	145p	165p	240p	380p
Double ended DIP (Header Plug) Jumper				
6 inches	185p	205p	300p	465p
12 inches	198p	215p	315p	490p
24 inches	210p	235p	345p	540p
36 inches	230p	250p	375p	595p

IDC Header Socket Jumper Leads 24"

	20 pin	26 pin	34 pin	40 pin
Single ended	160p	200p	260p	300p
Double ended	290p	370p	480p	525p

ANTEX SOLDERING IRON

C-15W	450p	CX17W	475p
CCN-15W	495p	CX25W	500p
Spare tips, assorted sizes			65p
Spare Elements			210p
Iron stand with sponge			165p

SIL SOCKET
0.1" pitch
20 way
65p

D CONNECTORS: Miniature

	9 way	15way	25way	37way
Plugs				
Solder lugs	80p	110p	160p	250p
Angle Pins	160p	210p	250p	355p
W/Wrap Pins	120p	130p	195p	295p
Sockets				
Solder lugs	110p	160p	210p	350p
Angled Pins	165p	215p	290p	440p
W/Wrap Pins	150p	180p	240p	420p
Covers	95p	95p	95p	110p
IDC 25 way plug 385p				Skt 450p

CRYSTALS

32.768KHz	100
100KHz	235
200KHz	268
455KH	370
1MHz	275
1.008M	275
1.28MHz	392
1.6MHz	395
1.8NHz	395
1.8432M	200
2.0MHz	225
2.4576M	200
3.278M	150
3.5794M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.80MHz	200
4.194304M	200
4.433619M	100
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	225
7.0MHz	150
7.168MHz	250
7.68MHz	200
8.0MHz	150
8.08333M	395
8.86723M	175
9.00MHz	150
10.0MHz	175
10.24MHz	200
10.7	150
12.0NHz	175
12.528M	300
14.31814M	170
16.0MHz	200
18.0MHz	180
18.432M	150
20.0MHz	200
19.968MHz	150
24.0MHz	170
24.930MHz	325
26.69M	150
27.648M	170
27.145M	190
38.66667M	175
48.0MHz	170
100.0MHz	295
116.0MHz	250

'WEMON' New Version WATFORD'S Ultimate Monitor IC

A 4K Monitor chip specially designed to produce the best from your Superboard Series I & II, Enhanced Superboard & UK101. As reviewed by Dr A. A. Berk in Practical Electronics, June 1981.

Only £10

RANSFORMERS:

-3V; 6-0-6V; 9-0-9V; 12-0-12V; 15-0-15V
100mA **98p**
mounting. Miniature, Split Bobbin
A: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A;
5V-0.1A **200p**
A: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A;
5V-0.2A **270p**
ndard Split Bobbin type:
A: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A;
5V-0.25A **220p**
A: 2x4.5V-1.3A; 2x6V-1A; 2x9V-0.6A;
2V-0.5A; 2x15V-0.4A; 2x20V-0.3A
295p (35p p&p)
A: 2x6V-1.5A; 2x9V-1.2A; 2x12V-1A;
5V-0.8A; 2x20V-0.6A **330p** (60p p&p)
A: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-
A; 2x20V-1.2A; 2x25V-1A; 2x30V-0.8A
465p (60p p&p)
cially wound for Multirail Computer PSUs
A giving +5V/5A; +12V; +25V; −12V @
575p (60p p&p)
VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A;
5V-2A; 2x30V-1.5A; 2x50V-1A **920p** (75p
charge to be added over and above our nor-
postal charge).

VOLTAGE REGULATORS

1A	TO220 +ve		Plastic Casing −ve	
5V	7805	40p	7905	45p
12V,	7812	40p	7908	60p
15V	7815	40p	7912	45p
18V	7818	40p	7915	45p
24V	7824	40p	7918	45p
			7924	45p

100mA TO92 Plastic package

5V	78LO5	30p	79LO5	60p
6V	78LO6	30p	–	
8V	78LO8	30p	–	
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

LM300H	170p	TAA550	50p
LM304H	170p	TDA1412	150p
LM305H	140p	78H05 +5V/5A	550p
LM309K	135p	78H12 +12V/5A	
LM317K	320p		580p
LM317KP	99p	78HG +5V to +25V	
LM323K	450p	5A	599p
LM337	175p	79HG +2.25V to 24V	
LM723 Var	36p	5A	685p

SOLDERCON PINS
Ideal for making SIL or DIL Sockets

100 pins	75p
500 pins	350p

ALUM BOXES

3 × 2 × 1"	65p
4 × 2½ × 2"	85p
4 × 2½ × 2½"	103p
4 × 4 × 2"	105p
4 × 4 × 2½"	120p
5 × 4 × 1½"	99p
5 × 4 × 2½"	120p
5 × 2½ × 1½"	90p
5 × 2½ × 2½"	130p
6 × 4 × 2"	120p
6 × 4 × 3"	150p
7 × 5 × 3"	180p
8 × 6 × 3"	210p
10 × 4 × 3"	240p
10 × 7 × 3"	275p
12 × 5 × 3"	260p
12 × 8 × 3"	295p

25 way 'D' CONNECTOR
Jumper Lead Cable Assembly

18" long, Single end, Male	495p
18" long, Single end, Female	525p
36" long, Double Ended, M/M	1025p
36" long, Double Ended, F/F	1050p
36" long, Double Ended, M/F	995p

● SPECIAL OFFER ●
TEX EPROM ERASER
Only
£29.95

BBC MICRO UPGRADE

(Our BBC Micro Upgrade Kits will save you £ s s s . . .)

16K Memory (8 × 4816AP)	£18
Printer User I/O Port Kit	£8.20
SK10 with 36" Cable	£2
Complete Printer Cable 36"	£12
SK9 with 36" Cable	£3
Disc Interface Kit	£41
Analogue I/O Kit	£6.75
Serial I/O Kit	£7.50
Expansion Bus Kit	£6.50
SK11 with Cable 36"	£3
SK12 with Cable 36"	£3.75
Complete Upgrade Kit from Model A to Mod. B	£45

Complete range of Connectors & Cables available. Send SAE for list

CMOS

4000	10
4001	10
4002	12
4006	50
4007	14
4008	32
4009	24
010	24
011	10
012	16
013	20
014	46
015	40
016	20
017	32
018	45
019	25
020	42
021	40
022	40
023	13
024	32
025	13
026	80
027	20
028	39
029	45
030	15
031	125
032	80
033	125
034	140
035	45
036	275
037	115
038	110
039	250
40	40
41	40
42	40
43	40
44	40
45	105
46	46
47	40
48	40
49	25
50	25
51	45
52	60
53	50
54	85
55	85
56	85
57	1915
59	435
60	45
61	1195
62	995
63	85
66	24
67	245
68	14
69	16
70	13
71	13
72	13
73	15
4075	13
4076	50
4077	13
4078	15
4081	13
4082	13
4085	50
4086	60
4089	125
4093	20
4094	70
4095	95
4096	70
4097	290
4098	75
4099	110
4160	95
4161	99
4162	99
4163	99
4174	99
4175	105
4194	105
4408	790
4409	790
4410	725
4411	675
4412	775
4415	480
4419	280
4422	770
4435	850
4440	999
4450	350
4451	350
4490	350
4500	675
4501	28
4502	60
4503	40
4504	75
4505	185
4506	35
4507	35
4508	130
4510	46
4511	45
4512	50
4513	199
4514	115
4515	115
4516	55
4517	275
4518	40
4519	30
4520	50
4521	110
4522	125
4526	70
4527	65
4528	70
4529	150
4530	90
4531	130
4532	70
4534	455
4536	275
4538	90
4539	110
4541	140
4543	80
4544	150
4548	40
4549	375
4553	245
4554	190
4555	35
4556	35
4557	320
4558	120
4559	395
4560	160
4561	104
4562	495
4566	165
4568	250
4569	175
4572	30
4580	460
4581	250
4582	99
4583	99
4584	48
4585	99
4597	330
4599	290
40085	90
40097	45
40098	193
40100	215
40101	130
40102	140
40103	175
40104	95
40105	110
40106	46
40107	60
40108	450
40109	100
40110	300
40114	240
40161	194
40163	65
40174	65
40175	75
40181	220
40182	90
40192	90
40193	68
40194	90
40195	72
40244	195
40245	195
40257	195
40373	240
40374	245
45106	595

OPTO

LS400C	255
OCP71	120
ORP12	86
ORP61	85
2N5777	45
BPX25	195
BPW21	295
BPX65	270

OPTO ELECTRONICS

LEDs with Clips

TIL209 Red	10
TIL211 Grn	14
TIL212 Yel.	14
TIL220 .2" Red	12
.2" Green, Yellow or Amber	14
0.2" Bi colour	
Red/Green	65
Green/Yellow	78
0.2" Tri colour	
Red/Green/Yellow	85
Hi-Brightness Red	59
Flashing red 0.2" red	55
Square LEDs, Red, Green, Yellow	30
Rectangle Stackable LEDs	
Red, Green or Yell	18
Triangular LEDs	
Red	18
Green or yellow	22
LD271 Infra Red	46
SFH205 Detector	118
TIL32 Infra Red	58
TIL78 Detector	60
TIL38	45
TIL100	80
BARGRAPH Red 10 segments	225
ISOLATORS	
IL74	55
ILD74	99
ILQ74	185
TIL111/2/4	90
TIL117	125
4N33 Photo Darlington	135
7 Segment Displays	
TIL307	675
TIL312 .3" CA	105
TIL313 .3" CC	105
TIL321 .5" CA	115
TIL322 .5" CC	115
DL704 .3" CC	99
DL707 .3" CA	99
FND357 Red	120
FND500	115
.3" Green CA	150
.6" Green CA	215
.3" ± 1 Red CA	150
.3" ± 1 Green CA	150
DVM176	1885
LCD 3½ Digits	495
LCD 4 Digits	530
LCD 6 Digits	625

NEONS
Rectangular, nut fixing
Red, Amber, Green **30p**
REFLECTIVE Optical Switch type TIL139 **170p**
SLOTTED Optical Switch similar to RS Comp.'s **186p**

COMPUTER CORNER

- **MX80FT/3 EPSON PRINTER** 10" & Friction feed, 9 × 9 matrix 80 column, Speed 80CPS, Bidirectional, Centronics Interface standard, Baud-rate 110-9600 (RS232, Hi-Res, Bit Image graphics, Subscript & Superscript, Italics & Underlining facility plus 500 sheets of paper FREE.
- **MX100 EPSON Printer.** 136 Column, 15" carriage, plus all the features of MX80FT/3. Plus FREE 500 sheets of Paper. .... **Only £425 + carr.**
- **SOFTY II.** An intelligent Eprom Programmer and Emulator. Accepts a 24 pin 5V Eprom. Has Memory Map TV Display. RS232 and Centronics I/P & O/P. Copies, Emulates and programs. RS 232 and centronics routines standard. PSU included. **£169**
- **TEX** EPROM ERASER Erases up to 32 ICs in 15-30 minutes... **£33**
- **TEX** EPROM ERASER with a safety switch **£35**
- **TEX** EPROM ERASER plus our Solid State ELECTRONIC TIMER **£44**
- **ELECTRONIC TIMER.** Solid state, 15-30 min. Connects directly to above Erasers. Protects your expensive Chips from overcooking. Our timer pays for itself in no time **£15**
- **SPARE** 'UV' Lamb bulb **£8**
- **5V/5A** Power Supply Ready-built & tested **£25**
- **POWER SUPPLY.** Regulated with Overload protection. Variable Output, 5V to 15V at 4A. Professionally finished **£38**
- **MULTIRAIL POWER SUPPLY KIT.** Especially designed for Micros. Tested output: +5V/5A; +12V; +25V; −12V of 1A **£37**
- **ABS** CASE Attractive, Beige/Brown for Superboard, UK101 NASCOM, or HOme brew (please state) **£26**
- **Stack-Pak** Unique stackable twin drawer racking system for storing cassettes. 5 Drawers (10 sections) including labels and 10 × C12 Computer grade cassettes **550p**
- **C12** COMPUTER GRADE CASSETTES in library cases **40p**
- 8½" Fan Fold paper (1000 sheets) **£7**
- 9½" Fan Fold paper (1000 sheets) **£7**
- **SEIKOSHA** GP100A Uni-hammer Printer, gives normal and double width characters as well as dot resoltuion graphics. 10" Tractor feed. Parallel Intface Standard FREE 500 sheet paper **£175**

FLOPPY DISC DRIVES

- **TEAC** FD-50A Sincle Uncased 40 track single sided **£125**
- **TEAC** Single FD-50A Cased with PSU **£180**
- **TEAC** Twin FD-50A Cased with PSU **£335**
- **TEAC** Single FD-50E 80 track cased with PSU **£238**
- **APPLE II** Interface card for above **£35**
- **SIEMENS FDD 100-5** Drive. Cased, head, motors, track zero micro switch & motor control PCB with read, write & control electronics plus cable. For Apple Microcomputer **£215**
- 5.25" Single Sided D/D Verbatim Diskettes in Packs of 10 .... **£18**
- 8" Single Sided D/D Verbatim Diskettes in Pack of 10 .... **£27**

NEC PC8023BE-C PRINTER

Europe's most popular Printer

100CPS bi-directional, Logic seeking, 80 column, 7 × 9 Dot matrix head, true descenders on lower case, Superscript & Subscript & Underlining facility. Proportional spacing, Forward & reverse line feed, Tractor or friction feed, Hi-res & block graphics. Auto underling. Plus FREE 500 sheets of Paper.

Price: **Only £320** + £7 carr.

DRAGON

The Family Computer

This 6809E Microprocessor based Computer has 32K memory expandable to 64K. The other features are:

- Nine Colours
- 5 Resolution Graphics from 16 × 32 to 256 × 192
- Extended Microsoft Colour Basic
- Advanced Graphic Commands
- 5 Octave Sound through TV Speakers
- Full Editing — Insert, Delete, Amend
- Conventional Full QWERTY Keyboard
- Simple Plug-in type connections for Joysticks Cartridges & Cassette
- Centronic Parallel Printer Port.
- 160 page 'BASIC' Manual

All you require is a colour TV or Monitor & mains supply and your DRAGON is Huffing & Puffing, Up & Running.

Only £173 (£4 carr.)

ULTIMUM

WATFORD'S own most versatile MICRO EXPANSION SYSTEM. Ideal for interfacing with APPLE, ATOM, DRAGON, PET, RESEARCH MACHINE, SPECTRUM, SUPERBOARD, VIDEO GENIE, ZX81, etc. Low Cost, High Spec. As published in P.E. starting from November 1982.

Send SAE for details.

elektor decoder

Volume 9 — Number 1 **ISSN 0308-308X**

Elektor Publishers Ltd., Elektor House,
10 Longport, Canterbury CT1 1PE, Kent, U.K.
Tel.: Canterbury (0227) 54430. Telex: 965504.
Office hours: 8.30 - 12.30 and 13.30 - 16.30.

EDITOR
P. Holmes

U.K. EDITORIAL
A. Quinlan T. Day

TECHNICAL EDITORIAL STAFF
J. Barendrecht
G.H.K. Dam
E. Krempelsauer
G. Nachbar
A. Nachtmann
K.S.M. Walraven

Technical telephone query service, Mondays only, 13.30 - 16.15, tel.: 0227-53474.

For written queries, letters should be addressed to dept TQ.
Please enclose a stamped, addressed envelope or a self-addressed envelope plus an IRC.

PUBLISHING MANAGER: A.J. Brialey
ASSISTANT PUBLISHING MANAGER: S. Barber
ADVERTISING MANAGER: S. Brooks
National advertising rates for the English-language edition of Elektor and international rates for advertising in the Dutch, French and German issues are available on request.

Bank: 1. Midland Bank Ltd., Canterbury, A/C no. 11014587
Sorting code 40-16-11, Giro no. 315.42.54
2. U.S.A. only: Elektor Publishers, File no. 1504,
Los Angeles, CA 90074,
Bank of America, A/C no. 12350-04207.
3. Canada only: The Royal Bank of Canada,
c/o Lockbox 1969, Postal Station A, Toronto,
Ontario, M5W 1W9. A/C no. 160-279-7.
Please make all cheques payable to Elektor Publishers Ltd. at the above address.

Elektor is published monthly. July/August is a double issue.

SUBSCRIPTIONS: Elektor Publishers Ltd., Elektor House,
10 Longport, Canterbury CT1 1PE, Kent, U.K.
Subscriptions: January to December inclusive:

U.K.	U.S.A./Canada		other countries	
	surface mail	airmail	surface mail	airmail
£ 8.50	$ 23.00	$ 39.00	£ 8.50	£ 17.50

Subscriptions normally run to December incl.

Back issues are available at original cover price.

Change of address: Please allow at least six weeks for change of address. Include your old address, enclosing, if possible, an address label from a recent issue.
Letters should be addressed to the department concerned:
TQ = Technical Queries
ED = Editorial (articles submitted for publication etc.)
ADV = Advertisements
ADM = Administration
EPS = Elektor printed circuit board service

The circuits are for domestic use only. The submission of designs or articles to Elektor implies permission to the publishers to alter and translate the text and design, and to use the contents in other Elektor publications and activities. The publishers cannot guarantee to return any material submitted to them. All drawings, photographs, printed circuit boards and articles published in Elektor are copyright and may not be reproduced or imitated in whole or part without prior written permission of the publishers.

Patent protection may exist in respect of circuits, devices, components etc. described in this magazine.
The publishers do not accept responsibility for failing to identify such patent or other protection.

Dutch edition: Elektuur B.V., 6190 AB Beek (L), the Netherlands.
German edition: Elektor Verlag GmbH, 5133 Gangelt, W-Germany.
French edition: Elektor Sarl, Le Seau, 59270 Bailleul, France.
Italian edition: Elektor, 20092 Cinisello B., Italy.
Spanish edition: Elektor, Villanueva, 19, 1.°, Madrid-1.
Greek edition: Elektor, Karaiskaki 14, Voula, Athens.

Distribution in U.K.:
Seymour Press Ltd., 334 Brixton Road, London SW9 7AG.

Copyright © 1983 Elektor Publishers Ltd., Canterbury.

Printed in the Netherlands.

ABC

What is a TUN?
What is 10 n?
What is the EPS service?
What is the TQ service?
What is a missing link?

Semiconductor types
Very often, a large number of equivalent semiconductors exist with different type numbers. For this reason, 'abbreviated' type numbers are used in Elektor wherever possible:

- '741' stand for µA741, LM741, MC1741, MIC741, RM741, SN72741, etc.
- 'TUP' or 'TUN' (Transistor, Universal, PNP or NPN respectively) stand for any low frequency silicon transistor that meets the following specifications:

$U_{CEO, max}$	20 V
$I_{C, max}$	100 mA
$h_{fe, min}$	100
$P_{tot, max}$	100 mW
$f_{T, min}$	100 MHz

Some **'TUN's** are: BC107, BC108 and BC109 families; 2N3856A, 2N3859, 2N3860, 2N3904, 2N3947, 2N4124. Some **'TUP's** are: BC177 and BC178 families; BC179 family with the possible exeption of BC159 and BC179; 2N2412, 2N3251, 2N3906, 2N4126, 2N4291.

- 'DUS' or 'DUG' (Diode Universal, Silicon or Germanium respectively) stands for any diode that meets the following specifications:

	DUS	DUG
$U_{R, max}$	25 V	20 V
$I_{F, max}$	100 mA	35 mA
$I_{R, max}$	1 µA	100 µA
$P_{tot, max}$	250 mW	250 mW
$C_{D, max}$	5 pF	10 pF

Some **'DUS'** are: BA127, BA217, BA218, BA221, BA222, BA317, BA318, BAX13, BAY61, 1N914, 1N4148.
Some **'DUG's** are: OA85, OA91, OA95, AA116.

- 'BC107B', 'BC237B', 'BC547B' all refer to the same 'family' of almost identical better-quality silicon transistors. In general, any other member of the same family can be used instead.

BC107 (-8, -9) families:
BC107 (-8, -9), BC147 (-8, -9), BC207 (-8, -9), BC237 (-8, -9), BC317 (-8, -9), BC347 (-8, -9), BC547 (-8, -9), BC171 (-2, -3), BC182 (-3, -4), BC382 (-3, -4), BC437 (-8, -9), BC414

BC177 (-8, -9) families:
BC177 (-8, -9), BC157 (-8, -9), BC204 (-5, -6), BC307 (-8, -9), BC320 (-1, -2), BC350 (-1, -2), BC557 (-8, -9), BC251 (-2, -3), BC212 (-3, -4), BC512 (-3, -4), BC261 (-2, -3), BC416.

Resistors and capacitor values
When giving component values, decimal points and large numbers of zeros are avoided wherever possible. The decimal point is usually replaced by one of the following abbreviations:

p (pico-) = 10^{-12}
n (nano-) = 10^{-9}
µ (micro-) = 10^{-6}
m (milli-) = 10^{-3}
k (kilo-) = 10^{3}
M (mega-) = 10^{6}
G (giga-) = 10^{9}

A few examples:
Resistance value 2k7: 2700 Ω.
Resistance value 470: 470 Ω.
Capacitance value 4p7: 4,7 pF, or 0.000 000 000 004 7 F . . .
Capacitance value 10n: this is the international way of writing 10,000 pF or .01 µF, since 1 n is 10^{-9} farads or 1000 pF.
Resistors are ¼ Watt 5% carbon types, unless otherwise specified.
The DC working voltage of capacitors (other than electrolytics) is normally assumed to be at least 60 V. As a rule of thumb, a safe value is usually approximately twice the DC-supply voltage.

Test voltages
The DC test voltages shown are measured with a 20 kΩ/V instrument, unless otherwise specified.

U, not V
The international letter symbol 'U' for voltage is often used instead of the ambiguous 'V'. 'V' is normally reserved for 'volts'. For instance: U_b = 10 V, not V_b = 10 V.

Mains voltages
No mains (power line) voltages are listed in Elektor circuits. It is assumed that our readers know what voltage is standard in their part of the world!
Readers in countries that use 60 Hz should note that Elektor circuits are designed for 50 Hz operation. This will not normally be a problem; however, in cases where the mains frequency is used for synchronisation some modification may be required.

Technical services to readers

- **EPS service.** Many Elektor articles include a lay-out for a printed circuit board. Some — but not all — of these boards are available ready-etched and predrilled. The 'EPS print service list' in the current issue always gives a complete list of available boards.
- **Technical queries.** Members of the technical staff are available to answer technical queries (relating to articles published in Elektor) by telephone on Mondays from 13.30 to 16.15. Letters with technical queries should be addressed to: Dept. TQ. Please enclose a stamped, self addressed envelope; readers outside U.K. please enclose an IRC instead of stamps.
- **Missing link.** Any important modifications to, additions to, improvements on or corrections in Elektor circuits are generally listed under the heading 'Missing Link' at the earliest opportunity.

BBC Micro Computer

Please phone for availability

BBC Model A	£ 299
BBC Model B	£ 399

(incl. VAT) carriage £ 8 unit.

Model A to Model B upgrade kit	£ 50.00
Fitting charge	£ 20.00

PRINTER & USER PORT KIT
IC69, 70, 71, PL9, 10 £ 9.50
Bus & Tube Port Kit £ 6.50

ANALOGUE PORT KIT
IC73, SK6 ...... £ 7.30
RS423 & VDU Port kit £10.80

MEMORY UPGRADE
8x4816 AP-3 100nS £21.60
F.D. INTERFACE KIT
IC77-78 .... £70.00

OFFICIAL BBC DEALER

All mating Connectors with Cables in stock. Full range of ACORNSOFT, PROGRAM POWER & BUGBYTE SOFTWARE AVAILABLE

Phone or send for our BBC leaflet

BBC FLOPPY DISC DRIVES

Single Drive 5¼" 100 K £ 235 + £ 6 carr.
Dual Drive 5¼" 800 K £ 799 + £ 8 carr.

BBC COMPATIBLE DRIVES

These are drives with TEAC FD50 mechanism and are complete with power supply
SINGLE: 100 K £ 190; 200 K £ 260; 400 K £ 340
DUAL : 200 K £ 360; 400 K £ 490; 800 K £ 610

NEW LOW PRICES

NEC PC 8023BC

100CPS, 80 cols Logic Seeking, Bidirectional, Forward and Reverse Line Feed, Proportional Spacing, Auto Underline, Hi-Res and Block Graphics, Greek Char. Set.

Only £ 320 + £ 8 carr

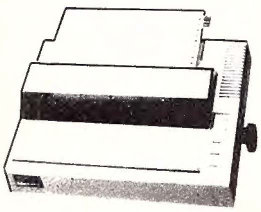
PRINTERS

SEIKOSHA GP 100A

80 cols 30 CPS Full ASCII & Graphics 10" wide paper

Now only £ 175 + £ 6 carr. Ask for details on GP250A

EPSON MX 80 and 100F/T3



MX 80 80CPS 80 cols
MX 100 100CPS 136 cols

Logic Seeking, Bi-directional, Bit Image Printing, 9x9 Matrix Auto Underline

MX 80 F/T3 £ 325
MX 100 F/T3 £ 430
(£ 8 Carr/Printer)

VARIETY OF PRINTER INTERFACES IN STOCK

PRINTER ACCESSORIES

2,000 fan fold papers with perforated margin ... £ 15 + £ 3.50 carr.

RIBBONS FOR PRINTERS

GP 100A	£ 6.50
EPSON MX80	£ 7.50
NEC PC8035	£ 7.50

AMPHENOL CONNECTORS

37 way Centronix Type (IDC or Solder Type)	£ 5.50
25 way IEEE Type	£ 5.50

DRAGON 32

*32K RAM *HI-LO Res Graphics *REAL TIME CLOCK *COLOUR *SOUND *PRINTER PORT
Only £ 173 + £ 4 carr.
Please phone to check availability Wide range of Software in Stock.

MICRODOCTOR

This is not a logic analyser or an oscilloscope. It tests a microsystem and gives a printed reprint on RAM, ROM and I/O – it will print memory map, search for code, check dataline shorts and operates peripherals

Microdoctor complete with PSU, printer, proble cable and two configuration board .... £ 295

SOFTY II INTELLIGENT PROGRAMMER

The complete micro processor development system for Engineers and Hobbyists. You can develop programs, debug, verify and commit to EPROMS or use in host computer by using softy as a romulator. Powerful editing facilities permit bytes, blocks of bytes changed, deleted or inserted and memory contents can be observed on ordinary TV.
Accepts most +5 V EPROMS
Softy II complete with PSU, TV Lead and Romulator lead .... £ 169

RUGBY ATOMIC CLOCK

This Z80 micro controlled clock/calendar receives coded time data from NPL Rugby. The clock never needs to be reset. The facilities include 8 independent alarms and for each alarm there is a choice of melody or alternatively these can be used for electrical switching. A separate timer allows recording of up to 240 lap times without interrupting the count. Expansion facilities provided.

Complete Kit	£ 120	+ £ 2.00 carr.
Ready Built Unit	£ 145	+ £ 5.00 carr.

Reprint of ETI articles at £ 1.00 + s.a.e.

UV ERASERS

UV1B up to 6 Eproms	£ 47.50
UV140 up to 14 Eproms	£ 61.50
UV1T with Timer	£ 60.00
UV141 with Timer	£ 78.00

(Carr £ 2/eraser)

All erasers are fitted with mains switches and safety interlocks.

MICROTIMER (HOUSEKEEPER)

6502 Based Programmable clock timer with
* 224 switching times/week cycle
* 24 hour 7 day timer
* 4 independent switch outputs directly interfacing to thyristor/triacs
* 6 digit 7 seg. display to indicate real time, ON/OFF and Reset times
* Output to drive day of week switch and status LEDs.

Full details on request. Price for kit £57.00

ACORN ATOM

Basic Built	£ 135
Expanded	£ 175

(carr £ 3/unit)

Atom Disc Pack £ 299 + £ 6 carr
3 A 5 V Regulated PSU £ 26 + £ 2 carr

Full Range of Atomsoft in stock. Phone or send for our BBC Atom list.

MONITORS

BMC BM1401 14" Colour Monitor RGB Input 18MHz Bandwidth
£ 240+ £ 8 carr
HI RES 12" Green Monitor Antiglare screen £99 + £ 6 carr
MICROVITEC 1431 M/S 14" Colour monitor RGB input
£ 269+ £ 8 carr
RGB Lead for BMC £ 8
Composite Videolead £ 3.50

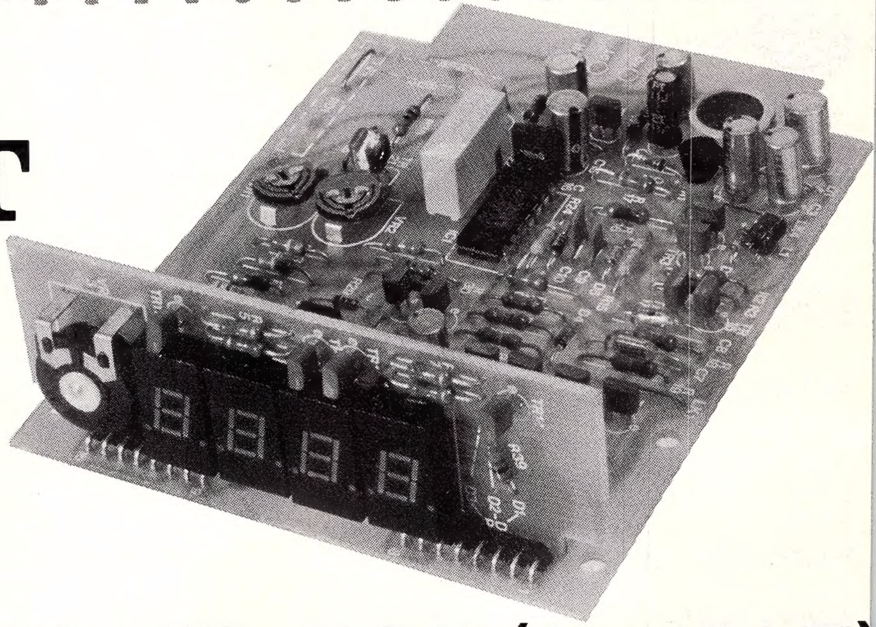
SEE OUR INSIDE FRONT COVER PAGE ADVERTISEMENT FOR COMPONENT PRICES

TECHNOMATIC LTD

MAIL ORDERS TO: 17 BURNLEY ROAD, LONDON NW10 1ED
SHOPS AT: 17 BURNLEY ROAD, LONDON NW10
(Tel: 01-452 1500, 01-450 6597. Telex: 922800)
305 EDGWARE ROAD, LONDON W2

PLEASE ADD 40p p&p & 15% VAT
(Export: no VAT, p&p at Cost)
Orders from Government Depts. & Colleges etc. welcome.
Detailed Price List on request.
Stock items are normally by return of post.

SPECIAL OFFER to Elektor readers



3½ DIGIT LED PANEL METER

for only £11.95 + 75p P&P (inc.VAT)

The DP 355 is a 3½ digit LED panel meter with a full scale input of ± 1.999 V D.C., and a basic accuracy of 0.5%. I has a very high input impedance (> 1 GΩ) and good linearity, typically 0.1%. The whole instrument operates from single 5 volt rail. Polarity and overload indication are automatically displayed.

There is provision on the pcb to fit either attenuator resistors to alter the input voltage for full scale or shunt resistor for current measurement. The decimal points are user programmable to correspond to the full scale voltage/current Full specifications and applications for use are included.

Don't miss this excellent offer closing date-31st Dec. 1982
Only a limited number of meters are available,
so order now while stocks last.
Complete the coupon below and mail it,
with your cheque or postal order,
to Elektor Publishers Ltd., 10Longport, Canterbury, Kent CT1 1PE
Please allow 28 days for delivery.

Please send me panel meter/s @ £ 11.95 + 75p p&p each.
I enclose cheque/P.O. for (payable to Elektor Publishers Ltd.)
NAME: ____________________
ADDRESS: ____________________
____
____

ELECTROVALUE

- 24 HOUR NORMAL DESPATCH TIME
- ESTABLISHED 1965
- ALL GOODS GUARANTEED BRAND NEW AND TO SPECIFICATION
- APPOINTED SIEMENS DISTRIBUTORS

I.Cs — COMPUTER & ANALOGUE

COMPUTER

74LS

74LS00	11
74LS02	11
74LS04	12
74LS05	12
74LS08	12
74LS10	12
74LS11	12
74LS14	30
74LS20	12
74LS30	12
74LS32	14
74LS37	14
74LS38	15
74LS42	28
74LS47	56
74LS51	14
74LS73	18
74LS74	18
74LS75	22
74LS76	19
74LS85	48
74LS86	20
74LS90	27
74LS92	32
74LS93	24
74LS107	40
74LS112	22
74LS123	38
74LS125	29
74LS126	27
74LS132	40
74LS136	25
74LS137	110
74LS138	30
74LS139	35
74LS145	70
74LS148	89
74LS151	40
74LS153	40
74LS153	40
74LS155	38
74LS156	36
74LS157	30

74LS161	37
74LS163	36
74LS164	43
74LS165	60
74LS166	90
74LS173	55
74LS174	45
74LS175	40
74LS191	50
74LS193	40
74LS195	39
74LS196	48
74LS197	60
74LS221	51
74LS240	55
74LS241	55
74LS242	75
74LS243	75
74LS244	60
74LS245	85
74LS251	55
74LS253	43
74LS257	35
74LS259	84
74LS266	28
74LS273	60
74LS279	40
74LS299	250
74LS367	34
74LS368	24
74LS373	84
74LS374	68
74LS378	60
74LS393	60

7400

7400	11
7401	11
7402	12
7403	12
7404	13
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14

7413	18
7414	20
7420	15
7430	14
7440	14
7442	32
7443	60
7444	60
7447	36
7448	40
7450	14
7451	14
7453	14
7454	14
7460	14
7470	24
7472	26
7473	26
7474	23
7475	32
7476	30
7480	35
7482	65
7482	65
7483	38
7485	60
7486	20
7489	159
7490	28
7491	35
7492	25
7493	25
7494	35
7495	35
7496	40
74100	80
74104	40
74107	22
74121	24
74123	40
74125	34
74126	33
74141	51
74151	40
74154	60
74155	39
74156	40

74157	30
74190	48
74192	48
74193	48
74393	95

CMOS

4000	10
4001	10
4002	12
4006	50
4007	14
4008	40
4009	24
4010	24
4011	12
4012	15
4013	20
4014	46
4015	40
4016	20
4017	35
4018	45
4019	25
4020	42
4021	40
4022	35
4023	14
4024	32
4025	14
4026	80
4027	20
4028	39
4029	45
4030	16
4041	44
4042	40
4043	40
4044	40
4046	46
4049	23
4050	23
4060	45
4069	14
4070	14
4071	14
4072	14

4081	14
4082	14
4093	20
4510	46
4511	46
4511	120
4516	53
4518	40
4520	60
4543	120
4583	130

All above prices are NET and shown in pence

ANALOGUE

709C5	49
709C14	44
723C14	36
741C5	57
741C8	18
741C14	47
747C14	65
748C8	35
1458C5	62
1458C14	40
7106	450N
7107	500N
555	23
7555	86
556	45
CA3046	78
CA3080E	86
CA3130E	99
CA3140E	55
LM301AN	26
LM308N	60
LM317K	321
LM324N	45
LM348N	65
LM380N	75
LM380N8	104
LM381N	145

LM382N	115
LM3900N	50
LM3914N	200
LM3915N	200
NE555V	23
NE556A	45
NE567N	104
RC4151NB	80
S041E	290
S041P	121
S042E	364
S042P	138
S89	11.23
S178B	31.00
S187	13.28
S566B	214
S576A	235
S576B	235
S576C	235
S576D	225
S1469	468
SAB0600	302
SAB3209	497
SAB3210	311
SAB3211	168
SAB3271	329
SAB4209	497
SAB8256C	35.40
SAD1024	15.50
SAJ131	238
SAJ141	224
SAJ205	810
SAS231W	260
SAS251	142
SAS580	196
SAS590	196
SDA5680A	15.55
TAA761	104
TAA761A	49
TAA765A	62
TAA861	103
TAA865A	59
TAA2761A	72
TAA4761A	113
TAA4765A	120

TAB1041W	187
TBA120AS	62
TBA120U	72
TBA400	100N
TBA800	75
TBA10S	75
TBA820	75
TBB1458	62
TBB1458B	40
TCA105	120
TCA105B	108
TCA105G	140
TCA250A	185
TCA205K	200
TCA335A	66
TCA345A	109
TCA345W	177
TCA671	131
TCA780	211
TCA871	114
TCA955	228
TCA965	136
TCA965K	170
TCA971	92
TCA991	80
TCA991K	100
TDA2002	120
TDA2003	126
TDA2030	150
TDA4050B	144
TDA4290	169
TDA4600	184
TDA4700A	546
TDA4718A	435
TFA1001W	252
TL071CP	45
TL072CP	75
TL074CN	120
TL081CP	46
UAA170	165
UAA170L	152
UAA180	165
UAA190	141
XR2206	520
ZN414	85
ZN424P	99
ZN425E	350

CRYSTALS

(in MHz)

0.032768	102	4.433	128
0.100000	453	4.915	157
1.000	453	5.000	157
1.8432	320	5.026	128
2.000	268	6.000	157
2.4576	268	6.144	157
3.2768	188	6.5536	128
3.579	128	8.000	1.88
4.000	102	8.867	128
4.194	128	10.000	157
		18.432	188

THERMISTORS
K164
Disk type, 5mm dia Resistance at 20°C; 6R8, 10, 22, 47, 100, 220, 470, 1K, 2K2, 4K7, 10K, 22k, 47K, 100k each **18p**

LOUDSPEAKERS

1½" dia 8Ω	70
2½" dia 8Ω	70
2½" dia 64Ω	70

DIN AUDIO

Pins	plug	skt
2	8p	8p
3	14p	8p
4	15p	14p
5 (180°)	17p	11p
5 (240°)	20p- 8p	
6		
7	19p	30p

JACK PLUGS, SKTS

MONO 25"			
chrome P1	53p	34p	42p
plastic P2	32p	14p	20p
STEREO 25"			
chrome P3	81p		52p
plastic P4	60p	15p	20p
Mono 3.5mm	18p		14p
Stereo	23p		42p

D—SERIES

9	78p	104p	92p
15	106p	140p	96p
25	141p	206p	110p
37	199p	298p	122p

IDC Connectors
DIL

14 way	103p
16 way	117p
24 way	170p
40 way	266p

PARALLEL TYPE

	Plug	Skt
2 × 8 way	192	184
2 × 10 way	225	206
2 × 13 way	279	258
2 × 17 way	333	299
2 × 20	382	315

Plugs have retainers. Sockets have strain relief

MAINS TYPE
1 E C style. 6A 250V
Cable socket 43R01 69

Cable plug 42R04	95
Chassis socket 43R04	63
Chassis plug 43R02	45

BNC (up to 500MHz) 50Ω

Plug UG88U	80
Line skt. UG290U	75
Round skt. UG1094U	

UHF 50Ω

Plug PL259	42
Round socket S0239SH	36

UHF/UHF couplers:

Plugs	83
Sockets	44

IC SOCKETS

pins	each	25 for
8	8p	1.60 N
14	12p	2.40 N
16	14p	2.80 N
18	16p	2.20 N
20	18p	3.60 N
22	21p	4.20 N
24	21p	4.20 N
28	22p	4.40 N
40	30p	6.00 N

TERMINALS

Plastic, screw, 15A several colours	24
S14 4mm socket	12
P14 4 mm plug	10
Wander plugs & sockets red/black only ea	14

PC Mounting terminal blocks 80am
2 way 17p, 4 way 33p, 6 way 49p, 8 way 66p, 10 way 82p, 12 way 98p

COAX (TV)

Plug	25
Line socket 48Socket	44

QUICK TEST
Mains connector — block, fused 525

CAPACITORS

Polystyrene, Siemens
5% Tolerance 160V
5, 7, 10, 12, 15, 18, 22, 27, 33, 39pF **15p**; 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820pF, 1n, 1n2, 1n5, 1n8, 2n2, 2n7, 3n3, 3n9, 4n7, **10p**; 5n6, 6n8, 8n2, 10n, **13p**
Ceramic Very small 1.8, 2.2, 2.7 etc, up to 1n **5p each.** 1n5, 2n2, 3n3, 4n7, 6n8, **5p**; 10n, 22n, **6p**; 33n, 47, **7p**; 100n, **8p**
Polyester, Siemens Layer Type 7.5mm lead spacing 100V
1n, 1n5, 2n2, 3n3m **6p**; 4n7, 6n8, 8n2, 10n 12n, 15n, 18n, 22n, 33n, 47n, **7p** 56n, 68n, **7p**; 82n, 100n, **9p** 120n, 150n, **15p**; 180n, 220n, **12p**; 270n, 330n, 330n, 390n, 470n, **15p**; 560n, 680n, **24p**; 10mm spacing 1uF **25p**; 15mm spacing 2u2 **35p**; 22.5mm, spacing 1uF 400V **50p**; 3.33uF 100V **69p**; In depth stocks.

ELECTROLYTICS

1/63	10
2.2/25	13
2.2/63	10
4.7/63	11
4.7/100	14
6.8/40	10
10/6	13
10/25	10
10/40	11
10/63	14
10/100	15
22/10	10
22/25	11
22/40	14
22/63	15
22/100	16
47/3	03
47/10	11
47/25	12
47/40	15
47/63	17
47/100	18
100/3	03
100/10	13
100/16	14
100/25	15
100/40	15
100/63	20
100/100	27
220/10	16
220/16	16
220/25	18
220/40	20
220/28	28
220/100	42
470/10	19
470/16	19
470/25	19
470/40	27
470/63	45
470/100	73

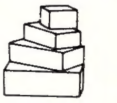
1000/10	19
1000/16	26
1000/25	36
1000/40	44
1000/63	76
2200/6	09
2200/16	44
2200/25	
2200/40	73
4700/16	72
4700/25	90

TANTALUM BEARS

0.1/35	13
0.22/35	13
0.47/35	13
1.0/35	13
2.2/16	13
2.2/35	16
4.7/16	16
4.7/35	18
6.8/16	16
6.8/25	24
10/6.3	16
10/16	18
10/25	18
22/6.3	18
22/16	30
22/25	30
33/6.3	24
33/10	30
47/6.3	30
100/10	80

For full ranges of very many other types please see Cat 82 and/or current price list.

BOXES



High quality Black ABS plastic or die-cast plain or stove grey.

L	W	D	ABS		Plain		Stove Gr	
50	50	25	—		5001P	90p	5001	123p
100	60	25	2002	96p	5002P	117p	5002	154p
113	63	31	2003	109p	5003P	143p	5003	184p
121	66	40	2004	115p	5004P	162p	5004	210p
152	82	50	2005	134p	5005P	216p	5005	268p
192	113	61	2006	235p	5006P	314p	5006	401p

VERO RANGE plastic boxes

L	W	D		
72	47	25	21024	51p
120	50	35	21390	83p
180	110	55	21391	151p

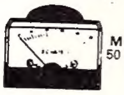
G RANGE professional Instrument Cases

134	90	44	21089	£7.28N
224	140	64	21090	£11.02N
302	170	84	21091	£14.96N

METERS

Large range of types in stock; also probes, leads, accessories, etc.
PANEL MOUNTING in 50, 100, 500μA; 1, 5, 10, 50, 100, 500mA; 1A either model.

T Range
60 × 45mm
£5.95



MU Range
50 × 45mm
£2.68

MULTIMETERS

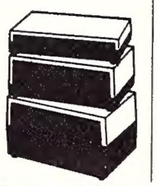
NH56A
NEW — 20KΩ/V AC/DC/-RES/dB in 23 ranges: 130 × 88 × 37mm
£11.20N

YN360TR
20KΩ/V: AC/DC/R/dB/Transistor Test: in 21 ranges: 145 × 96 × 45mm
£16.45N

VEROBOX CASES

to give a completely professional finish to a much valued project.
ABS, light grey top; dark grey bottom + 2 anodised panels

L	D	H	TYPE	PRICE
205	140	40	21034	£4.52
205	140	75	21035	£5.02
205	140	110	21036	£6;54
180	120	39	21037	£4.11
180	120	65	21038	£4.40
180	120	90	21039	£4.69
155	85	39	21040	£3.31
155	85	60	21041	£3.31
155	85	80	21042	£4.30
125	65	30	21047	£2.35
125	65	39	21048	£2.99
125	65	50	21049	£3.37



SEMICONDUCTORS

1N914	03
1N914B	10
1N916	05
1N4007	06
1N4148	03
1N5402	14
1N5407	18
2N697	23
2N706	18
2N930	20
2N1132	23
2N1302	110
2N1303	58
2N1304	62
2N1305	62
2N1306	90
2N1307	67
2N1308	147
2N1309	99
2N1599	100
2N1613	25
2N1711	25
2N1893	32
2N2218A	31
2N2219A	25
2N2222A	25
2N2369A	21
2N2484	25
2N2646	45
2N2904	26
2N2904A	25
2N2905A	25
2N3053	23
2N3054	55
2N3055	48
2N3405	64
2N3663	15
3702-11	09
2N3771	180
2N3794	21

2N3819	22
2N3820	40
3823	60N
2N3904	15
2N3906	15
2N4036	46
2N4058-62	09
2N4124	25
2N4126	25
2N4284	30
2N4286	18
2N4289	23
2N4291	24
2N4292	21
2N4991	62
2N5062	32
2N5192	110
2N5195	106
2N5457	32
2N5458	32
2N5459	36
2N6050	380
2N6057	375
6F40	152
16F40	165
40HF40	225
40361DIS	
40362	65
40406	71
40408	95
40412	108
40430	100
40594	123
40595	123
40636	147
40673	145
A9903	16
AA113	13
AA116	13
AA117	13

AA118	14
AA119	13
AC126	25
AC127	25
AC128	25
AC151R	55
AC153K	20
AC176	25
ACY17	155
ACY18	120
ACY19	99
ACY20	90
ACY21	85
ACY39	170
ACY41	10
AD136	530
AD142	90
AD149	88
AD161	35
AD162	35
AF114	37
AF115	37
AF116	57
AF117	110
AF124 AF125	37
AF126	37
AF127	37
AF200	10
AF239	114
AF279	30
AFY12	204N
AFY16	327N
AFY180	310N
AFY18E	615N
AFY42	461N
AU106	240
AU111	(use
AU116)	
AUY22	10.95
BO140	25N

BO146	30N
BO226	45N
B1906	38
BA379	25
BAS40-03	36
BAS70-03	41
BAT14-036	11.75
BB409	33
BC107A,B	16
BC108A,B,C	16
BC109B,C	18
BC121W	30N
BC122Y	100
BC125	20
BC125	20
BC140	30
BC141	30
BC147A	10
BC149	10
BC154	25
BC160	30
BC161	30
BC167A	09
BC167B	09
BC168A	09
BC168B	09
BC169B	09
BC169C	09
BC177B	16
BC178B	16
BC179B	18
BC182	09
BC182L	09
BC183	09
BC183L	09
BC184	09
BC184L	09
BC202Y	120
BC212	09
BC212L	09
BC213	09
BC213L	09

BC214	09
BC214L	09
BC238C	09
BC239C	09
BC258B	09
BC267B	16
BC300	26
BC301	24
BC303	30
BC327	16
BC328	11
BC337	14
BC338	11
BC413	09
BC414	09
BC477	29
BC546	10
BC547	09
BC548	09
BC549	09
BC550	10
BC556	10
BC557	09
BC558	09
BC559	09
BC560	10
BC879	38
BC880	43
BCY31A	157
BCY58	18
BCY70	18
BCY71	18
BCY72	18
BD130	45N
BD131	48
BD132	48
BD135	27
BD136	27
BD139	30
BD140	32
BD644	42N
BD679	62
BD680	64
BF115	35
BF167	25
BF173	25
BF177	25
BF178	25
BF244B	40
BF254	14
BF255	14
BF420	31
BF421	34
BF457	35
BF458	35
BF459	35
BF597	12N
BFR34A	84

BFR39-41	23
BFR79-81	23
BFT65	119
BFT66	192
BFX29	24
BFX84	24
BFX85	24
BFX87	28
BFX88	26
BFY50	24
BFY51	24
BFY52	24
BFY90	143
BR34	70
BR64	110
BRY39	45
BSX20	22
BSX26	22
BSX63	769N
BT106	147
BT108	136
BU105	170
BU124	85
BU208	180
BUX26	350N
BUX28	545
BUX81	744
BUX85	249
BUZ10A	478
BUZ15	12.27
BUZ20	523
BUZ23	787
BUZ24	12.50
BUZ32	625
BUZ33	844
BUZ41A	637
BUZ44A	9.67
BUZ45	12.76
BUZ48	18.94
BUZ50A	763
BUZ54A	21.43
BUZ80	739
BUZ83	11.29
BUZ83A	11.95
BUZ84A	12.75
BY164	48
C106D1	45
C0326	460N4
C0340	490N4
C407	17
C0546	126N1
C762	40
C1406	77
D4 clip	for
C1406	and
E2506	10
D1046	88
E1110	76

E1210	76
E2506	154
EB383	20
MJ2955	90
MJE340	55
MJE2955	95
MJE3055	70
MPF102	40
MPS6531	40
MPS6534	42
MPSA12	36
MPSA63	38
NAS206S5	81
OA47	12
OA90	10
OA91	10
OA95	DIS
OA202	14
OC28	75
OC29	75
OC35	75
OC36	90
OC84	25
PM7A2	373
PN70	10
PN72	05
Q4006LT	104
Q4010LT	115
Q4025H	450
T2700D	189
T2800D	104
TAG3-400	100
TAG209-400	85
TAG209-600	130
TIC106D	48
TIC106M	55
TIC126D	64
TIC206D	54
TIC226D	61
TIC236D	96
TIC246D	105
TIP31A	36
TIP32A	36
TIP41A	45
TIP41C	60
TIP42A	45
TIP42C	60
TIP150	75
TIP2955	55
TIP3055	55
TIS43	50
U763	50
VN10KM	55
VN46AF	93
VN66AF	105
VN88AF	123
W02	25

POTENTIOMETERS

Carbon Rotary (P20) 100ohms — 4M7 lin. 220ohms — 2M2 log. **32p each** w.switch **87p.** Dual gang (JP20) 4K7 — 1M2 lin, or log **95p** w.switch **£1.50**

SLIDERS
58mm, low cost 10K 1M log only **29p.** Std 58mm mono 4K7 — 1M lin. or log **74p** stereo matched **£1.25.** Graduated bezels **34p each.**
PRESET
Min. 10mm dia. Hrix. or Vert. 100ohms — 1M **13p**
Preset Cermet rectilinear type 89P 100ohm — 1m **£1.06 each**
Preset Cermet 10mm dia. Horiz. or Vert. 100ohm — **29p**
Plesseyu MPW T moulded carbon 47ohms — 2M2 **59p each.**

RF Chokes
1, 1.1, 4.7, 10, 47μH ea **42p,** 100, 22μH **53p,** 470μH, 1mH **73p.**

PANEL LAMPS

LED chrome, red	54
LED yellow or green (high efficiency)	70
Filament in red, amber, green or clear.	
6V 60 mA	48
14V 40 mA	54
LED's	
5mm red	10
yellow	19
green	16
Mountings, B65	3

DISPLAYS
7-segment
Common anode

MAN72A red	**75**
MAN82A yellow	110
MAN52A green	110

Common cathode

MAN74A red	**85**
MAN84A yellow	110
MAN54A green	110

5V filament

3015F 8 mA	**255**
3015F 15 mA	**255**

KNOBS black plastic

K1 skirted with spot	16
K2 as K1, 35mm	21
K3 pointer	15
K7 19 mm knurled	23
K8 as K7 + skirt	23

RECHARGEABLE CELLS
AA **99p** C **227p** D (4AH) **376p**
PP3 cell (7-2V 410
PP3 charger **495N**

CHARGER FOR ABOVE
for any two pairs AA, Cor D No NC1230 **820N**

BUZZERS
6-15V solid state 70

SOLDERING IRONS

Also large stocks of bits, desoldering devices, accessories, etc.
ANTEX C-240V **£4.60N;** X.25-240V **£5.30N;** CSBP **£5.45N;** XSBP **£5.56N;** ST4 Stand **£1.70N**
ORYX 50 watt temp. controlled **£13.75N**
SOLDER 500gm/18SWG **£7.60N;** Desolder braid 1.5m **54p**

SWITCHES

Type CK—1P/12 way, 2P/6 way, 3P/4 way, 4P/3 way **48p;** Min Toggles — S7101 SPDT **57p;** S7201 DPDT **80p;** S7301 3PDT **£1.64;** S7203 DPDT **96p;** Push Button min. 8531 make/8533 break **62p;** 8225 DPDT **£1.34.**
DUAL IN LINE ERG colour coded 0.3" × 0.1" format. On/Off single throw 2P SDS2 **54p;** 4P SDS4 **95;** 6P SDS6 **£1.38;** 8P SDS8 **£1.87;** 10P SDSO **£2.10.** *Low cost* D-I-L 4P DNS04 **65p;** DNS08 **£1.00**

LATEST PRICE LIST
includes many new additions to items in our catalogue.
CATALOGUE incl 70p refundable voucher, 70p post free with price list.
Large S.A.E. brings price list only FREE

RESISTORS

1/4, 1/3, 1/2, 3/4 watt — **all 2p each,** 10 of one value **15p**
2% Mullard metal film 5.1 ohms — 300K **5p each,** 10 of one value **40p**
5% wire wound 3W or 7W, most E12 values 1.2ohms to 8K2 **9p each** 10 for **70pN**

CREDIT CARD ORDERS can be accepted via Mail Order or Telephone. Giro A/c no. 38/671/4002

VAT additional at 15% on all UK orders
FREE POSTAGE and packing on UK C.W.O. orders value £5.75 (inc. VAT) and upwards. Under £5.75 add 40p (inc. VAT)
DISCOUNTS on orders over £23.00 — 5%
££57.50 — 10%
Not applicable to 'Net' items (shown by 'Net' after the price) or to orders paid for by credit cards.

PLEASE MENTION THIS JOURNAL WHEN ORDERING OR WRITING IN TO US

ELECTROVALUE LTD

Head Office, Mail Order Dept and Shop
28 K St. Judes Road, Englefield Green, Egham, Surrey TW20 0HB Telephone Egham (STD 0784: London 87) 33603; Telex 264475
Also in Manchester for personal shoppers at:—
680 Burnage Lane, Burnage, Manchester M19 1NA
Telephone 061-432 4945
Computing Shop North:—
700 Burnage Lane, Manchester Telephone 061-431 4866

Marshall's

A. Marshall (London) Ltd.
85 West Regent Street, Glasgow G2 2QD.
041-332-4133. Tlx 261507 ref 2194

WISH ALL THEIR CUSTOMERS A HAPPY AND BUSY 1983, AND REMIND THEM THAT ALL SALES, BOTH RETAIL AND INDUSTRIAL, ARE NOW HANDLED FROM OUR GLASGOW ADDRESS:

RING GAVIN BRIGGS OR ALAN SUGDEN ON:
041-332-4133

for PRICES AND QUOTATIONS FOR ALL YOUR ELECTRONIC REQUIREMENTS – INSTRUMENTS, COMPONENTS AND ACCESSORIES – also KITS.

WE NO LONGER HAVE ANY ADDRESS IN LONDON, BUT WE KNOW YOU WILL BE A SATISFIED CUSTOMER IF YOU CONTINUE TO DEAL WITH MARSHALLS, THE FIRM WHO HAVE BEEN IN THE BUSINESS FOR MORE THAN TWENTY YEARS!

Marshall's

A. MARSHALL (London) Ltd.

(0600 6363 for 'Mrs. M.')

CDS

Send Cash/Postal Orders/Cheques made out to:
COMPONENT DISTRIBUTION SERVICES
Grange Farm, Back lane,
East Langton, Market Harborough.
Leicestershire.
For goods by RETURN.

Full Kit of Semiconductors required for 'CRESCENDO'

B1,B2	KBPC 2502 x 2
D1,D2	BZY 88C3V9 x 2
D3,D4	BZY 88C12 x 2
D5,D6	1N4148 x 2
T1,T2,T6	BC 546A x 3
T3,T4,T5	BC 556A x 3
T7	BC 560C x 1
T8	BF 470 x 1
T9	BC 550C x 1
T10	BF 469 x 1
T11,T12	2SK135 x 2
T13,T14	2SJ50 x 2
TOTAL	**£ 20.00** For FULL Kit

STK080 = 30 Watt RMS Mono Audio Amp **£ 2.50** ea incl FULL DATA

TDA 2002 = 7 Watt RMS **£ 2.00** Per PAIR Incl Full DATA

Please mention

elektor

when ordering goods or requesting information from advertisers.

TIME CLOCKS

200-250 V, 50 Hz Motor – 24 Hour Spun Aluminium Dial – SP. Isolated, 15 A Contacts Manual Overide Button – 3"x3.25"x2.25" deep – Integral mounting bracket.
British made . . . . **£ 4.95 EACH.** P & P £ 1.00

7 Day version as above but individual days can be selected to switch as required eg: stay off weekends or switch on in seven days time etc **£ 7.95 EACH.** P & P £ 1.00

HIGH QUALITY RELAYS

220-250 V Coil, 2 PCO 5 A gold plated contacts, 1"x0.7"x1.3" high, P.C.B. mounting . . . . **£ 1.00 EACH 6 FOR £ 5.00**

12 V Coil Miniature Low Profile P.C. Mounting 2 PCO 1.2" x 0.9" x 0.4". Gold Plated contacts 2 A . . . . **£ 1.50 EACH 4 FOR £ 5.00**

24 V Coil (will switch on 12 V DC) 2P normally closed. 10 Amp. Silver contacts 1.2"x1.2"x1.8" high **£ 1.00 EACH 6 FOR £ 5.00**

24 V DC Coil Miniature P.C.B. 1"x0.4"x1" high S.P.C.O. G.P. Silver 5 A Contacts **80p EACH 5 FOR £ 3.50**

P & P 1-6 RELAYS 50p 6 OR MORE £ 1.00

TO 220 REGULATORS

7812 1 A 12 V + VE
7805 1 A 5 V + VE
40p EACH 10 FOR £ 3.20
100 FOR £ 25.50 P & P 30p

MINIATURE BEAD THERMISTORS

3 kΩ @ 0°C, 100 Ω @ 100°C. Ideal for making Thermometers etc.
£ 1.50 PER PAIR on PTFE Leads P & P 30p

'SIEMENS' FULL SPEC LED'S Red, Yellow, Green

0.125"	**10 of one colour £ 1.00**	**10 OF EACH £ 2.50**
0.2"	**10 of one colour £ 1.00**	**10 OF EACH £ 2.50**

P & P 30p

THORN VIDEOSTAR NICAD PACKS VA214
12 V 1.8 Ah
Contain 10 x "C" Cells (HP 11) which alone would cost in excess of £20.00 These are all ex-equipment but are a superb buy at £8.00 each or 3 for £20.00 **postage – for one pack £1.00 for 3 packs £2.00**

7 SEGMENT DISPLAYS

0.4"	FND 353 Common Cathode	**40p EACH**	**10 FOR £ 3.00**
0.56"	FND 510 Common Anode	**60p EACH**	**10 FOR £ 4.00**
0.8"	FND 850 Common Cathode	**90p EACH**	**10 FOR £ 6.00**

All supplied with Connection Sheets.

ALL PRICES INCLUDE VAT

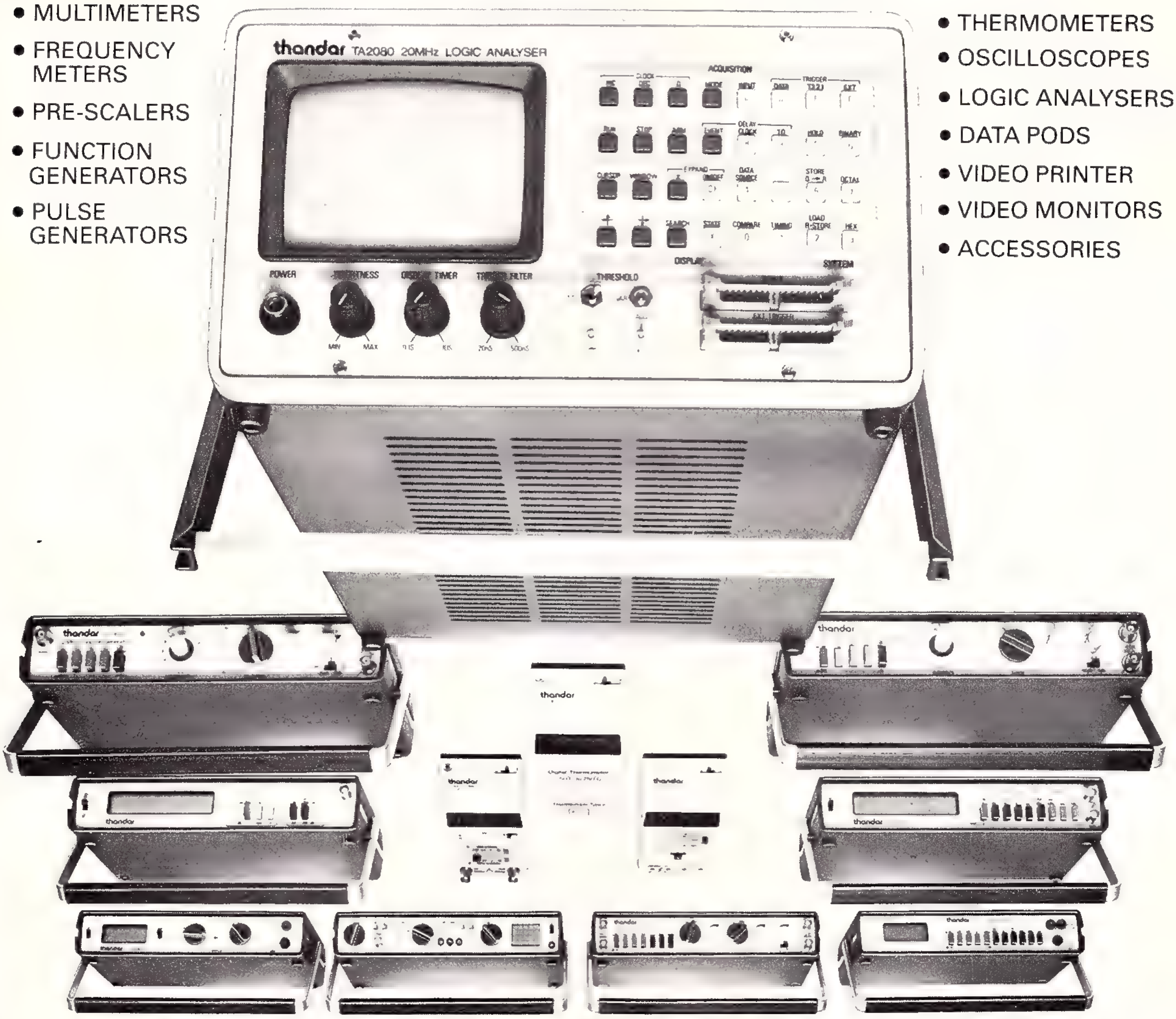
GEMINI ELECTRONIC COMPONENTS
Dept K. "The Warehouse" Speedwell street, Deptford, London, S.E.8

Thandar's unbeatable price/performance combination means every engineer, serviceman and technician can enjoy the benefits of full performance portable test instruments.
Quality and reliability has been brought to a wide range of low cost instrumentation. From multimeters through to logic analysers Thandar have applied the knowledge gained through a history of innovative electronics to give you robust instruments with professional specifications versatile enough for bench or field use at prices that are hard to beat.
Most of the products in the range can be combined with accessories which expand applications beyond the realms of low cost testing. Mains or battery operation and low weight make them truly the most portable instruments available today.
All Thandar instruments carry a one-year warranty.

PUTTING THE BEST WITHIN YOUR GRASP

- MULTIMETERS
- FREQUENCY METERS
- PRE-SCALERS
- FUNCTION GENERATORS
- PULSE GENERATORS

- THERMOMETERS
- OSCILLOSCOPES
- LOGIC ANALYSERS
- DATA PODS
- VIDEO PRINTER
- VIDEO MONITORS
- ACCESSORIES



thandar
ELECTRONICS LIMITED

London Road, St. Ives, Huntingdon,
Cambridgeshire PE17 4HJ England.
Tel: (0480) 64646. Telex: 32250.

TH04

BRADLEY MARSHALL LTD.

SPECIALIST ELECTRONIC COMPONENT DISTRIBUTORS

325 Edgware Road, London W2 1BN Telephone: 01-723 4242 Telex: 295441 BUSY B

1983 CATALOGUE NOW AVAILABLE

Probably the largest stock of ICs and Transistors in the South

TRY US FIRST!

SEND LARGE SAE & 75p TO ADDRESS BELOW

Crimson Elektrik

PROFESSIONAL AMPLIFIER MODULES

CODE	DESCRIPTION	Less VAT £	VAT £	INC VAT £	WT (Kg)
CE 608	Power Amplifier Module	18.26	2.74	21.00	0.16
CE 1004	Power Amplifier Module	21.30	3.20	24.50	0.20
CE 1008	Power Amplifier Module	23.90	3.60	27.50	0.21
CE 1704	Power Amplifier Module	30.43	4.57	35.00	0.22
CE 1708	Power Amplifier Module	30.43	4.57	35.00	0.22
CE 3004	Power Amplifier Module	42.60	6.40	49.00	0.40
BD 1	Bridge Driver Module	7.13	1.07	8.20	0.06
TR 80	Toroidal Transformer 80VA	18.00	2.70	20.70	2.00
TR 150	Toroidal Transformer 150 VA	20.07	3.01	23.08	2.35
TR 250	Toroidal Transformer 250 VA	25.43	3.81	29.24	3.35
TR 250Q	Toroidal Transformer (low noise)	33.20	4.98	38.18	2.80
B 6	Bridge Rectifier (6 amp)	0.99	0.15	1.14	0.02
B 12	Bridge Rectifier (12 amp)	1.80	0.27	2.07	0.03
C4700/40	Reservoir Capacitor and Clip	1.91	0.29	2.20	0.09
C4700/63	Reservoir Capacitor and Clip	2.40	0.36	2.76	0.11
C4300/63	Reservoir Capacitor and Clip	2.60	0.39	2.99	0.11
CPS 80	Power Supply	22.82	3.42	26.24	2.10
CPS 80D	Dual Power Supply	27.63	4.14	31.77	2.25
CPS 150	Power Supply	25.86	3.88	29.74	2.50
CPS 150D	Dual Power Supply	31.65	4.75	36.40	2.60
CPS 250	Power Supply	32.03	4.80	36.83	3.50
CPS 250D	Dual Power Supply	39.43	5.91	45.34	3.65
TS 70	Thermal Switch 70°C	1.92	0.29	2.21	0.02
HS 50	50mm Heatsink	1.60	0.24	1.84	0.15
HS 100	100mm Heatsink	2.60	0.39	2.99	0.30
HS 150	150mm Heatsink	3.65	0.55	4.20	0.45
FM 1	Fan Mounted on 2 x HS 100	32.13	4.82	36.95	1.20
FM 2	Fan Mounted on 2 x HS 150	36.10	5.42	41.52	1.50
CPR 1X	Pre-Amplifier Module	31.30	4.70	36.00	0.15
MC 2	Moving Coil Pre-Pre-Amplifier Module	20.00	3.00	23.00	0.07
REG 1	**Regulated Power Supply**	8.09	1.21	9.30	0.07
TR 6	6VA Mains Transformer	2.87	0.43	3.30	0.21
XO 2	2 Way Crossover Module	17.39	2.61	20.00	0.07
XO 3	3 Way Crossover Module	26.09	3.91	30.00	0.07
MU 1	Muting Circuit for XO 2 or XO 3	8.35	1.25	9.60	0.04
CK 1010	Complete Pre-Amplifier Kit	78.26	11.74	90.00	2.50
CK 1040	Complete 40 Watt Power Amplifier Kit	103.48	15.52	119.00	7.30
CK 1100	Complete 100 Watt Power Amplifier Kit	129.56	19.44	149.00	7.30
MC 2K	Add On Moving Coil Kit	21.74	3.26	25.00	0.12
PSK	Pre-Amplifier Power Supply Kit	17.39	2.61	20.00	0.75

SOLE DISTRIBUTION BRADLEY MARSHALL LTD. 325 EDGWARE ROAD, LONDON W2 1BN. TEL: 01-723 4242

MOVING?

Mail to:

ELEKTOR PUBLISHERS., ELEKTOR HOUSE,
10 LONGPORT, CANTERBURY. CT1 1PE.

Please attach magazine label here, list new address below, and mail six to eight weeks before you move. If you are receiving duplicate copies of Elektor, please send both labels. Or if you have a question about your subscription attach label here and clip this form to your letter.

Surname

Initials

Street/Ave./Blvd.

Town

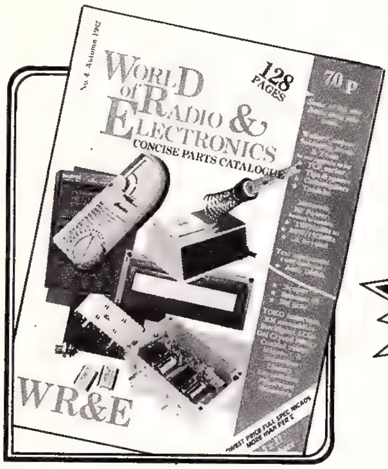
County/Province/State

Post code/Zip/Area code

Country

3 × £1 DISCOUNT VOUCHERS

ambit's new autumn/winter catalogue is OUT NOW!



128 PAGES

ALL THE 'USUAL' BITS
(Rs, Cs, Tr's, ICs etc)
+ ALL THE
TRICKY BITS

70p
at all good
newsagents
or direct

- ⋆ TOKO COILS, INDUCTORS, LC FILTERS
- ⋆ PCM FILTERS, VHF/UHF HELICAL FILTERS
- ⋆ UNELCO CAPACITORS
- ⋆ PCI INTELLIGENT LCD MODULES
- ⋆ TOKO SWITCHES : F SERIES/R7000 SERIES
- ⋆ ALPS POTENTIOMETERS AND KEYSWITCHES
- ⋆ TOYO-TSUSHO COAX RELAYS FOR TX/RX
- ⋆ CRYSTAL FILTERS, CERAMIC FILTERS
- ⋆ WELLER SOLDERING IRONS
- ⋆ COOPER TOOLS
- ⋆ TEST EQUIPMENT
- ⋆ BOOKS, MANUFACTURERS' HANDBOOKS
- ⋆ HARDWARE, CASES, PANELWARE, ETC.
- ⋆ MODULES, R&EW KITS
- ⋆ RF POWER DEVICES

ORDERS SUBMITTED USING STOCKCODES
DESPATCHED WITHIN 8 WORKING HOURS

⋆ PHONE ORDER SERVICE — (NO MACHINES!)
PLEASE NOTE OUR NEW PHONE SYSTEM AUTOMATICALLY STACKS CALLS IN ORDER OF ARRIVAL SO PLEASE WAIT IF NOT ANSWERED IMMEDIATELY
8 AM — 7 PM MON — SAT
0277 230909

⋆ COMPUTER ORDER SERVICE — 'REWTEL'
6 PM — 9 AM 300 BAUD/RS232
(IT MAY BE 24 HRS BY THE TIME YOU READ THIS)
0277 230959

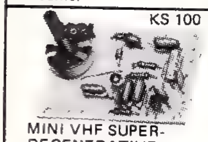
ambit INTERNATIONAL
200,NORTH SERVICE ROAD
BRENTWOOD, ESSEX
CM14 4SG
Telephone : (0277) 230909
Telex: 995194 AMBIT G

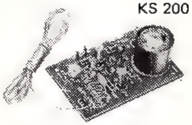
BARCLAYCARD VISA
Access

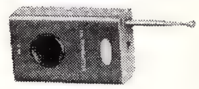
AMTRON UK LTD
ELECTRONIC KITS

7 HUGHENDEN
ROAD, HASTINGS,
SUSSEX. TN34 3TG
Telephone:
HASTINGS (0424)
436004

Post & Packing 50p for KS kits, 75p for UK kits, £1.00 for Cabinets. Send 20p S.A.E. for catalogue of our extensive range of kits & Cabinets. Trade, Educational & Export enquiries welcome.

KS 100

MINI VHF SUPER-REGENERATIVE RECEIVER
88-108 MHZ 9 V D.C.
£ 5.27 inc V.A.T.

KS 200

Mini FM Transmitter
88-108 MHz 9 V d.c.
(not licenceable in UK)
£ 7.37 inc V.A.T.

UK 108

MINIATURE F.M. TRANSMITTER.
NOT LICENCEABLE IN U.K.
£ 9.46 inc V.A.T.

KS 238

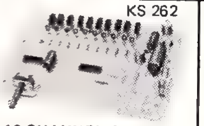
3 CHANNEL MICROPHONE OPERATED SOUND TO LIGHT,
300 W PER CHANNEL,
240 V A.C.
£ 11.58 inc V.A.T.

KS 240

3 CHANNEL SOUND TO LIGHT, OUTPUT
3 x 1 KW 240 V
£ 13.70 inc V.A.T.

KS 260

3 CHANNEL CHASE LIGHT, 1 KW PER CHANNEL, 240 V A.C.
£ 10.52 inc V.A.T.

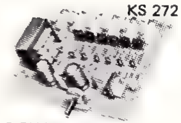
KS 262

10 CHANNEL CHASE LIGHT, 300 W PER CHANNEL, 240 V A.C.
£ 14.73 inc V.A.T.

UK 716

THREE-WAY STEREO MIXER, PHONO, AUX, MICROPHONE
£ 24.21 inc V.A.T.

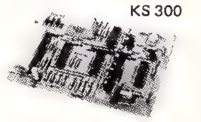
UK 232

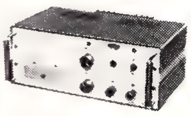
ANTENNA AMPLIFIER FOR AM/FM,
A.M. GAIN 25 dB
FM 15 dB
£ 5.27 inc V.A.T.

KS 272

6 CHAN HIGH POWER VU DISPLAY, 300 W PER CHAN, 240 V A.C.
£ 15.79 inc V.A.T.

UK 718

STEREO STUDIO MIXER, INPUTS:
2 PHONO, 1 TAPE,
1 AUX, 2 MICROPHONE
£ 69.45 inc V.A.T.

KS 300

WESTMINSTER CHIMES (BIG BEN)
6-10 V D.C.
£ 9.48 inc V.A.T.

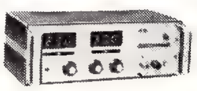
UK 677/A

REGULATED SUPPLY
0-20 V, 2.5 A
£ 54.23 inc V.A.T.

UK 558

600 MHz PRESCALER
+ 5 V D.C.
£ 28.42 inc V.A.T.

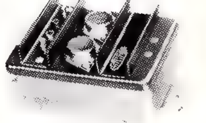
UK 562

TRANSISTOR AND DIODE TESTER
£ 14.73 inc V.A.T.

UK 666

0-30 V, 2.5 A REGULATED SUPPLY WITH DIGITAL DISPLAY
£ 76.82 inc V.A.T.

UK 733/A

PSYCHEDELIC LIGHTS CONTROL
1 K.W. PER CHANNEL
BASS-MIDDLE-TREBLE CONTROLS
£ 23.15 inc V.A.T.

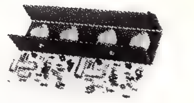
UK 875

Capacitive Discharge Electronic Ignition
£21.54 inc V.A.T.

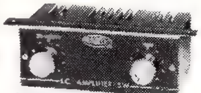
UK 882

CENTRALIZED ANTI-THEFT ALARM
£ 33.67 inc V.A.T.

UK 406

PORTABLE SIGNAL TEACER, COMPLETE WITH R.F. PROBE
£ 24.21 inc V.A.T.

KS 230

15 + 15 W R.M.S. STEREO AMPLIFIER
24-30 V D.C.
£ 16.84 inc V.A.T.

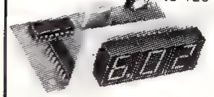
UK 271

INTEGRATED CIRCUIT AMPLIFIER WITH TONE & VOLUME CONTROLS
£ 8.42 inc V.A.T.

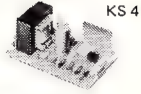
UK 823/W

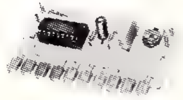
CAR BURGLAR ALARM. READY ASSEMBLED
£ 11.58 inc V.A.T.

KS 470

SOUND OPERATED SWITCH, 9-12 V D.C. COMPLETE WITH MICROPHONE
£ 8.42 inc V.A.T.

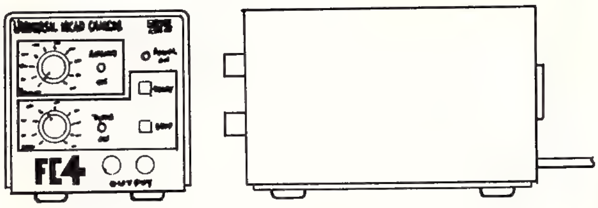
KS 420

DIGITAL D.C. VOLTMETER,
999 MV-999 V,
0.5 V D.C.
£ 17.89 inc V.A.T.

KS 490

NICAD BATTERY CHARGER,
10-20-45-100-150 mA,
15 V D.C. MAX
240 V A.C.
£ 8.42 inc V.A.T.

KS 143

L.E.D. VU DISPLAY, INPUT 1-100 W
5-12 V D.C.
£ 9.48 inc V.A.T.

UNIVERSAL NICAD CHARGER TYPE FC4

£24.50 + £1.50 P&P



Power requirement	: 240 V AC 60 Watts.
Constant current generator	: Variable from 10 mA to 4 amps, Log Scale. 'Regulation OK' lamp extinguishes on too high a load.
Auto Timer	: Variable from 1 min. to 60 mins. + 14 hrs. switched position. Manual start and stop buttons. Timer on lamp.
Other indicators	: Power on lamp, mains switch on current control knob.
Capabilities	: Will trickle charge at 14 hrs. rates up to 12, 1.2 V Cells or 2 110 mAH 8.2 V mass plate cells. Will fast charge up to 7 of most types of sintered 1.2 V cells within one hour.

At 4 amp rate	: D Cells	60 mins.
	C Cells	30 mins.
	506 C Cells	18 mins.
	AA Cells	7 mins.

(Note: Lower currents and longer times may of course be used)

SOUTHERN TECHNICAL SYSTEMS,
UNDERLYN FARM,
MAIDSTONE ROAD,
MARDEN,
KENT TN12 9BE
Telephone Maidstone 831022

---

for your copies of Elektor

THE ELEKTOR CASSETTE BINDER

This cassette style binder will help to keep your copies of Elektor clean and in order, even though you refer to them time and time again. The chamfered corner of the cassette allows instant recognition of each month's issue without the need to thumb through pages of previous months' issues. Because no wires or fastenings are used copies can be easily removed and replaced and each cassette will hold one year's volume of Elektor. Their smart appearance will look good on any laboratory shelf.

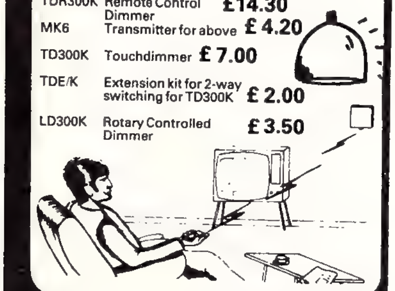
PRICE £2.90
inc. postage & packing

available from —
Elektor Publishers Limited,
10 Longport,
Canterbury,
Kent CT1 1PE.
please use the order card in this issue.

HOME LIGHTING KITS

These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300w. of lighting.

TDR300K	Remote Control Dimmer	£14.30
MK6	Transmitter for above	£ 4.20
TD300K	Touchdimmer	£ 7.00
TDE/K	Extension kit for 2-way switching for TD300K	£ 2.00
LD300K	Rotary Controlled Dimmer	£ 3.50



HOME CONTROL CENTRE

This New Remote Control Kit enables you to control up to 16 different appliances anywhere in the house from the comfort of your armchair. The transmitter injects coded pulses into the mains wiring which are received by receiver modules connected to the same mains supply and used to switch on the appliance addressed. Receivers are addressed by means of a 16-way keyboard, followed by an on or off command. Since pushing buttons can become rather boring, the transmitter also includes a computer interface so you can programme your favourite micro to switch lights, heating, electric blanket, make your coffee in the morning, etc., without rewiring your house. JUST THINK OF THE POSSIBILITIES. The KIT includes all PCBs and components for one transmitter and two receivers, plus a drilled box for the transmitter.

Order as XK112. £42.00

Additional Recievers XK111 £10.00

ELECTRONIC LOCK KIT XK101

This KIT contains a purpose designed lock IC, 10-way keyboard, PCBs and all components to construct a Digital Lock, requiring a 4-key sequence to open and providing over 5000 different combinations. The open sequence may be easily changed by means of a prewired plug. Size: 7 x 6 x 3 cms. Supply: 5V to 15 V d.c. at 40uA. Ouput: 750mA max. Hundreds of uses for doors and garages, car anti-theft device, electronic equipment, etc. Will drive most relays direct. Full instructions supplied.

ONLY £10.50

Electric lock mechanism for use with latch locks and above kit . £13.50

CHRISTMAS PRESENTS GALORE

3-NOTE DOOR CHIME

Based on the SAB0600 IC the kit is suppied with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 x 71 x 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS. Order as XK102.

£5.00

LIGHT DIMMER KIT

Contains all components, including front panel and knob, to make a dimmer for lights up to 300W.

£3.50

MW RADIO KIT

Based on ZN414 IC, kit includes PCB, wound aerial and crystal earpiece and all components to make a sensitive miniature radio. Size: 5. 5 x 2. 7 x 2 cms. Requires PP3 9V battery. IDEAL FOR BEGINNERS.

£5.00

LCD 3½ DIGIT MULTIMETER

16 ranges including DC voltage (200 mv-1000 v) and AC voltage, DC current (200 mA-10 A) and resistance (0-2 M) + NPN & PNP transistor gain and diode check. Input impedance 10M. Size 155x88x31 mm. Requires PP3 9v battery. Test leads included

ONLY £29.00

DVM/ULTRA SENSITIVE THERMOMETER KIT

This new design is based on the ICL7126 (a lower power version of the ICL7106 chip) and a 3½ digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (–50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week.

Price £15.50

DISCO LIGHTING KITS

DL 1000K

This value-for-money kit features a bi-directional sequence, speed of sequence and frequency of direction change, being variable by means of potentiometers and incorporates a master dimming control. **£14.60**

DLZ100K

A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum. **Only £8.00**

Optional opto input DLA1 Allowing audio ("beat") —light response. **60p**

DL3000K

This 3 channel sound to light kit features zero voltage switching, automatic level control & built in mic. No connections to speaker or amp. required. No knobs to adjust – simply connect to mains supply & lamps. (1Kw/Channel) **Only £11.95**

STOCKING FILLERS

PACK (1)	650 Resistors 47 ohm to 10 Mohm - 10 per value £4.00
PACK (2)	40 x 16V Electrolytic Capacitors 10uF to 1000uF - 5 per value £3.25
PACK (3)	60 Polyester Capacitors 0.01 to 1 uF/250V - 5 per value £5.55
PACK (4)	45 Sub-miniature Presets 100 ohm to 1 Mohm - 5 per value £2.90
PACK (5)	30 Low Profile IC Sockets 8, 14 and 16 - pin - 10 off each £2.40
PACK (6)	25 Red LEDs (5mm dia.) £1.25
PACK (7)	20 BC182 NPN General Purpose Transistors £1.20
PACK (8)	20 BC212 PNP General Purpose Transistors £1.20

All full spec. branded devices

BUY ANY 5 PACKS AND WE WILL SEND YOU 10 RED LEDs FREE

"OPEN-SESAME"

The XK103 is a general purpose infra-red transmitter/receiver with one momentary (normally open) relay contact and two latched transistor output. Designed primarily for controlling motorised garage doors and two auxillary outputs for drive/garage lights at a range of up to 40 ft. The unit also has numerous applications in the home for switching lights, TV, closing curtains, etc. Ideal for aged or disabled persons.

The Kit comprises a mains powered receiver, a four button transmitter, complete with predrilled box, requiring a 9V battery and one opto-isolated solid state switch kit for interfacing the receiver to mains appliances. As with all our kits, full instructions are supplied.

ONLY £23.75

ALL PRICES EXCLUDE VAT

REMOTE CONTROL KITS

MK6 SIMPLE INFRA RED TRANSMITTER
Pulsed infra red source complete with hand-held plastic box. Requires a 9V battery **£4.20**

MK7 INFRA RED RECEIVER
Single channel, range approx 20ft. Mains powered with a triac output to switch loads up to 500W at 240V ac. **£9.00** (RC500K –Special Price for MK6 and MK7 together **£12.50**

MK8 CODED INFRA RED TRANSMITTER
Based on the SL490, the kit includes all components to make a coded transmitter and only requires a 9V (PP3) battery and keyboard. 8 x 2 x 1.3cms **£5.90**

MK10 16-WAY KEYBOARD
For use with MK8 and MK18 to generate 16 different codes for decoding by the ML928 or ML926 receiver (MK12) kit. **£5.40**

MK11 10-Channel + 3 Analogue o/p IR Receiver
Based on ML922 decoder IC. Functions include on/standby output, toggle, control of volume, tone and lamp brightness. Includes its own mains supply. **£12.00**

MK12 16-CHANNEL IR RECEIVER
For use with MK8 kit with 16 on/off outputs, which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Latched or momentary outputs – please specify when ordering. Includes its own mains supply. **£11.95**

MK13 11-WAY KEYBOARD For use with MK8, MK18 and MK11 kits. **£4.35**

MK16 Mains Powered IR Transmitter
Mains powered for continuous operation – single channel, for applications such as burglar alarms, automatic door openers, etc. Range approx. 6 ft. **£2.50**

MK17 12V d.c. IR RECEIVER
For use with MK6 or MK16. Relay output with DP 3 Amp change-over contacts, may be used as latched, momentary or "break beam" receiver. Operates from 6-13V d.c. **£9.50**

MK18 HIGH POWER IR TRANSMITTER
Similar to MK8 but with range of approx. 60ft. **£6.20**

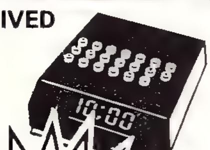
Ancillary Kits : MK2 Solid State Relay
Opto-isolated with zero voltage switching. No. triac supplied. **£2.60**

MK15 DUAL LATCHED SOLID STATE RELAY
Comprises 2 x solid state relays and latch for use with momentary version of the MK12. 2 output triacs required (not supplied). **£4.50**

THE MULTI-PURPOSE TIMER HAS ARRIVED

Now you can run your central heating, lighting, hi-fi system and lots more with just one programmable timer. At your selection it is designed to control four mains outputs independently, switching on and off at pre-set times over a 7 day cycle, e.g. to control your central heating (including different switching times for weekends), just connect it to your system programme and set it and forget it—the clock will do the rest.

FEATURES INCLUDE:-
* 0.5" LED 12 hour display.
* Day of week, am/pm and output status indicators.
* 4 zero voltage switched mains outputs.
* 50/60Hz mains operation.
* Battery backup saves stored programmes and continues time keeping during power failures. (Battery not supplied).
* Display blanking during power failure to conserve battery power.
* 18 programme time sets.
* Powerful "Everyday" function enabling output to switch every day but use only one time set.
* Useful "sleep" function–turns on output for one hour.
* Direct switch control enabling output to be turned on immediately or after a specified time interval.
* 20 function keypad for programme entry.
* Programme verification at the touch of a button.



NOW ONLY £39 WITH SO MANY EXTRA FEATURES. OPTIONAL BLACK PLASTIC CASE. READY DRILLED £2.50

(Kit includes all components, PCB, assembly and programming instructions). ORDER AS CT5000

24 HOUR CLOCK/APPLIANCE TIMER KIT

Switches any appliance up to 1kW on and off at present times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triacs, PCBs and full instructions.

CT1000K Basic Kit	£14.90
CT1000K with white box (56/131 x 71mm)	£17.40
(Ready Built)	£22.50

FREE **SHORT FORM CATALOGUE** – send SAE (6" x 9"). We also stock Vero, Books, Resistors, Capacitors, Semi-Conductors etc.

Add 55p postage & packing +15% VAT to total.
Overseas Customers;
Add £2.50 (Europe), £6.00 (elsewhere) for p&p.
Send S.A.E. for further STOCK DETAILS.
Goods by return subject to availability.

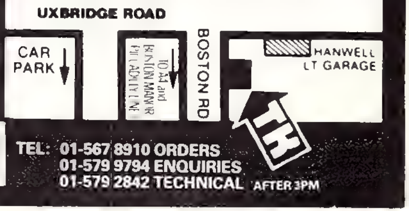
OPEN 9am to 5pm (Mon to Fri)
10am to 4pm (Sat)

FAST SERVICE · TOP QUALITY · LOW LOW PRICES

ELEKTOR PCBs NOW AVAILABLE

TK ELECTRONICS
11 Boston Road
London W7 3SJ

ACCESS and BARCLAYCARD welcome


CLOCK TOWER
EALING & NORTH CIRCULAR RD
UXBRIDGE ROAD
CAR PARK
TO A4 and BOSTON MANOR PICCADILLY LINE
BOSTON RD
HANWELL LT GARAGE
TK

TEL: 01-567 8910 ORDERS
01-579 9794 ENQUIRIES
01-579 2842 TECHNICAL AFTER 3PM

T. POWELL

311 EDGWARE ROAD, LONDON W2. TELEPHONE 01 723 9246

ELEKTOR KITS

*Ioniser	9823	
all parts including PCB		£ 12.50
case, front panel, switch and neon		£ 6.50
*Auto Ioniser	82162	£ 10.00
*Mosfet Hi-Fi Power Amplifier	82180	£ 33.25
*Triopede	82179	£ 14.00
*Guitar Tuner	82167	P.O.A.
*High frequency lighting for Model Railways	82157	£ 15.00
*Door Alarm	82172	£ 21.50
*House Telephone System	82147-1/2	£ 19.75
*Time Receiver for the Rugby M.S.F.	80524	P.O.A.
*Three Phase Tester	82577	£ 11.50
*L.C.D. Thermometer	82156	£ 23.75
*Darkroom Computer	82141-1/2/3	P.O.A.
*Active Aerial	82144-1/2	£ 15.25
*Light Sensitive Switch	82528	£ 4.20
*Sound Effects Generator	82543	£ 11.50
*Artist	82014	£ 58.00
*6502 Housekeeper	81170-1/2	£ 59.50
*TV Sound Interface	82094	£ 9.00
*Dynamic RAM Card	82017	£ 31.25
*2114 RAM Tester	82090	£ 6.50
*Wind Sound Generator	82066	£ 6.95
*Automatic Squelch	82077	£ 6.85
*Teletext Power Supply	82065	£ 12.40
*2716/2732 Programmer	82010	£ 23.50
*Frequency Multiplier	82041	£ 8.95
*Flashing Lights	82038	£ 6.90
*High Boost	82029	£ 7.95
*Telephone Amplifier	82009	£ 8.50
*Shutter Speed Meter	82005	£ 27.95
*Pest Pester	80130	£ 3.50
*Steam Train	80019	£ 6.50
*Scrambler	81142	£ 14.50
*Parametric Equaliser (inc. 4 PCBs)	9897-1/2	£ 34.50
*Talk Funny	80054	£ 10.00
*Elektornado	9874	£ 19.50
*VHF/UHF TV Modulator	9967	£ 5.50
*Pre-consonant	9954	£ 6.20
*Cassette Interface	9905	£ 14.00
*Audio Analyser	9932	£ 14.00
*Power Flasher	78003	£ 3.50
*Disco Ceiling Lights	81012	£ 70.00

OTHER KITS

R.F. Noise Bridge	ZW15	£ 22.50
S.W.R. Warning Alarm	ZW18	£ 6.20
*Beginners Short-Wave Receiver	ZW11	£ 13.50
Active Receiving Antenna	ZW10	£ 9.00
Beginners 2 metre Converter	ZW6	£ 15.00
Wide Band R.F. Preamplifier	ZW8	£ 7.50
A.F. Speech Processor	ZW14	£ 18.50
Fuzz Box	ZB106	£ 6.75
Lights Reminder for Car	ZB32	£ 5.25
Microchime Door Bell	ZB96	£ 15.00
Electronic Canary	ZB19	£ 5.00
Warbling Timer	ZB5	£ 6.75
Electronic Tuning Fork	ZB7	£ 11.50
Slide/tape Synchroniser	ZB42	£ 11.50
Micro Music Box	ZB45	£ 19.00
Audio Effects Unit	ZB122	£ 12.25
3 Channel Sound to Light	ZB127	£ 19.00
Soil Moisture Monitor	ZB132	£ 5.00
3 Channel Stereo Mixer	ZB141	£ 16.50
L.E.D. Dice	ZB146	£ 7.50
Digital Rule Ultrasonics	ZB148	£ 28.00
*Xenon Strobe Lamp	ZB161	£ 15.50
L.E.D. Sand Glass	ZB162	£ 5.50
Audio Compressor Mixer	ZB168	£ 13.50
Model Train Chuffer	ZB175	£ 7.25
Ice Warning for Cars	ZB226	£ 5.50
*2K RAM Pack (Mem. Exp. ZX81)	ZB230	£ 11.00

***No cases supplied**

Reprints of all above projects 40p each (+ S.A.E. if no kit required)

SPECIAL OFFERS

2732 EPROM	each	£ 4.00
AD 161/162	matched pairs	£ .50
1N4148 diodes	100	£ 1.50
BY 127 diodes	10	£ 1.20
	100	£ 10.00
Ultra sonic transducers transmit/receive	pair	£ 1.00
Computer electrolytics 21,000 µ 40 V		£ 3.50

BIG DISCOUNTS ON LARGE QUANTITIES
VAST SELECTION OF ELEKTOR BACK ISSUES

Access

All prices include post & 15% V.A.T.
Personal callers ring first to check availability of kits.
VISA/ACCESS welcome.

BARCLAYCARD VISA

VERY WIDE SELECTION OF ELECTRONIC COMPONENTS- CMOS,TTL,LS,TRANSISTORS etc.

MANY BARGAINS FOR CALLERS. VISIT OUR SHOP AT...

311 EDGWARE ROAD, LONDON W2.

or telephone 01 723 9246
Shop hours: Mon. to Sat. 9a.m. – 6p.m.
Closed Xmas Eve
No phone calls Saturday afternoon

Cutting costs with sparks

by R.A.J. Arthur

A new technique for machining hard metals is 50 times faster than the closest comparable process. It promises great benefits to the aircraft and motor industries and, because it can be used under water, will be a valuable aid for offshore work.

Using sparks in liquids to drill holes in hard metals under the sea, though it sounds arcane enough to conjure up the ghost of Jules Verne, is a literal description of Aberdeen University's latest contribution to underwater technology. A revaluation of existing methods has led a research team at the University to a novel way of removing metal 50 times faster.

One technique of spark erosion developed in recent years for drilling or cutting to shape some of the very tough, heat-resistant alloys needed in the aircraft, motor-vehicle and offshore oil industries is Electrodischarge machining (EDM). It offers an alternative to expensive high-energy beam processes such as laser and electron beam drilling.

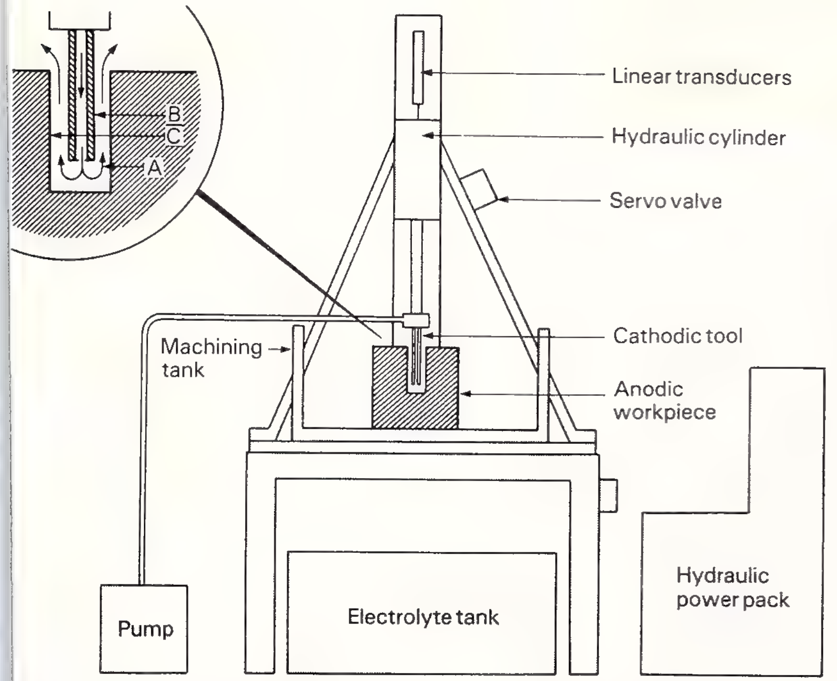
But EDM, though it can drill accurate holes, has the disadvantage of causing damage to surfaces. It cannot be used under water, and is slow in comparison with another recent technique, electrochemical machining (ECM), which removes metal by electrolyses. ECM leaves a better surface than EDM, but the effect can be spoiled by accidental sparking, which often occurs in long holes of small diameter.

The technique now developed combines the principles of EDM and ECM, is completely suitable for undersea application and brings a remarkable gain in speed and flexibility. Called Electrochemical Arc Machining (ECAM), it was evolved by the team at Aberdeen, led by Dr J. McGeough of the Department of Engineering.

Electrolysis and Sparks

Up to 50 times as fast as EDM, the new process depends, as does ECM, on the passage of direct current through an electrolyte, an ion-containing solution in which positively-charged ions move towards the cathode and negatively-charged ions towards the anode of an electric circuit, thereby releasing reaction products. In ECAM, this electrolysis is supplemented by spark erosion: a shower of tiny sparks (or, more precisely, arcs) cuts or drills metals to any desired shape.

There are lightweight tools for divers to use the process, complete with a power pack. Because the electrode never actually makes contact with the work surface and does not need to rotate like a drill, it can be of any shape, depending on the type of cut, and a soft metal can be used to machine a hard one. Other possible ECAM applications include rapid removal of surplus material on car bodies, metal turning and wire cutting.



Schematic diagram of an ECAM drilling machine. Sparking in the electrolyte takes place at the leading edge (A). Along the side walls (B, C) electromechanical machining nsures a bright, smooth finish.

In the ordinary EDM process the workpiece acts as one electrode and the tool as the other. To remove metal, a shower of erosive sparks is discharged across a dielectric.

Although most erosion occurs on the workpiece, there is also tool erosion, which, by well-chosen process conditions and tool materials, can be reduced to about one per cent of workpiece erosion.

In ECM the metal is removed from the anodic workpiece by electrolysis. The process is known as electropolishing, which is electroplating in reverse, and here, too, the cathode is the shaping tool. A small gap between the two electrodes is filled by an electrolyte. Electrolytic dissolution from the anode removes metal at a higher rate than is possible with EDM.

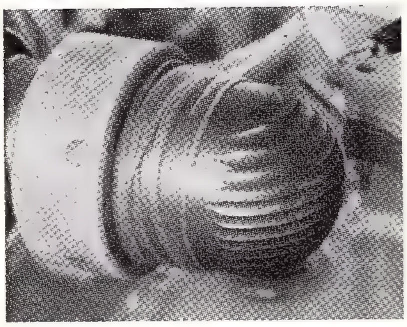
Whereas sparking does the work in EDM, in ECM it is a defect to be eliminated, with measures to prevent short-circuiting. From this came the germ of an idea that the powerfully eroding sparks could be made to play a positive part in a process based on electrolysis.

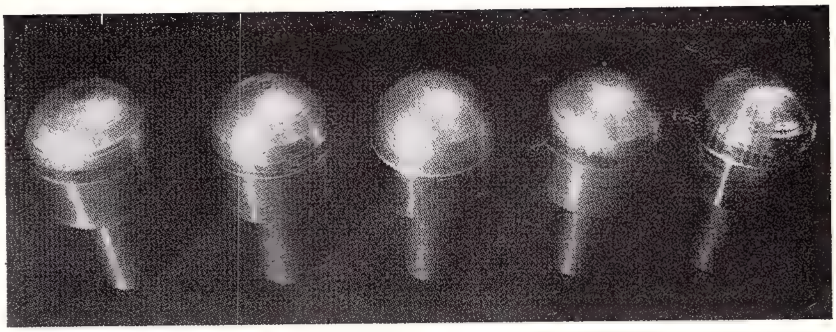
Thermal action

The principle of ECAM is to augment the electrochemical action by thermal metal removal. The lifetime of the sparks is extended. In this technique a spark is regarded as a transient, noisy discharge between two electrodes and an arc as a stable thermionic phenomenon. Discharges with durations from about 1 µs to about 1 ms are sparks, and those of 0.1 s are arcs. Discharges in ECAM, with their duration, energy and time of ignition completely under control, are not really sparks but short-duration arcs. Such arcs remove metal by intense heat; more metal is removed simultaneously by electroplating in reverse as a flow of electrolyte under pressure is maintained in the gap (typically 1 mm) between tool and anodic workpiece, which could be a large object such as a ship's hull or an underwater structure.

In some versions, the electrolyte is pumped out from the hollowed centre of a copper cathode tool, to flow between tool and workpiece where it also serves to flush out debris, gas and heat. The similarity between saline electrolytes and sea water makes the sea as natural an element for ECAM work as paraffin or light oil is for EDM.

One factor to do with the high rate





Left: A component milled under computer control. Its surface has been left with cusp-like irregularities, common in the manufacture of dies and moulds; the traditional way of producing a smooth surface is to finish it by hand. Right: Components similar to that on the left, after various stages of ECAM and ECM. ECAM rapidly removes the cusps and about half a minute of ECM leaves the surface bright and smooth.

of metal removal is the use of electrode vibration. In the basic experimental apparatus, the vibration is applied to the anodic workpiece by a hydraulic ram, which also feeds in the workpiece to the tool.

The apparatus compromises a system for controlling the movement of the electrode, an electrolyte flow system, a power supply and instrumentation to enable process conditions to be monitored. The ram which advances the anode to provide tool-feed, vibrating it at the same time, operates from a hydraulic cylinder. Motion of the ram is controlled by a differential amplifier that receives a ramp voltage from a function generator.

Ram feed-rate is preset by adjusting the frequency of the signal generator. Ram oscillation frequency is controlled by the output frequency of the generator and can be locked to that of the pulsed d.c. power supply. The amplitude of ram oscillation can be controlled by the amplitude of the output signal of the signal generator and also from the differential amplifier. Ram position can be adjusted from the differential amplifier.

Electrolyte

In some applications, the electrolyte is a 25 per cent (weight/volume) aqueous solution of sodium nitrate at a temperature of between 18 °C and 21 °C. It is drawn from a storage tank by a diaphragm pump, and a control valve in the flow line to the drill-electrode allows pressure to be present in the range from 13 bar to 120 bar. During drilling, electrolyte pressure is kept constant at 30 bar. With a one-millimetre gap between electrodes, the rate of flow is typically 6 l/min reducing to about 2.5 l/min with the deepening of the hole.

The cathodic drill electrode, a hollow copper tube 50 mm long and with an inside diameter of 1.325 mm and outside diameter 3.175 mm is soldered to a threaded bolt and screwed into a brass electrolyte manifold. Anodic workpieces used in experiments consisted of mild steel blocks mounted on a Perspex block.

The means for the formidable rate of metal removal in ECAM was provided by exploiting certain characteristics of sparks in an electrolyte. Increasing the electric field across the electrodes or decreasing the gap causes the neutral particles to become ionized by electrons emitted from the cathode and accelerated towards the anode; the positively-charged ions (cations) are accelerated towards the cathode. As more and more ionization takes place, a chain reaction builds up and creates an avalanche of ions in a region of complex interactions, that is, the plasma channel. Full development of a spark is very rapid and, once initiated, the spark can be maintained by a much lower voltage. Temperatures of many thousands of degrees Celcius in the plasma channel mean that any electrolyte or metal debris in the path of the discharge will be quickly evaporated, leading to the explosive expansion of a high-pressure bubble. Forces that oppose expansion include local pressure of the electrolyte, inertial and viscosity forces, and possibly also electromagnetic forces associated with high current density.

Power density

Current densities of the order of 10^6 to 10^{10} A mm^{-2} may occur in the discharge channel, giving power densities that cause the electrode temperature to rise at a rate of 10^9 to 10^{10} °C s^{-1}, and even sparks of a few microseconds duration lead to melting of the electrodes.

It is only when the voltage drops and the spark declines that the sudden removal of pressure allows an explosive removal of evaporated metal, and some in a molten condition, from the superheated electrodes. Though other complex mechanisms are at work, this is how most of the thermal removal of metal takes place.

Once conclusion is that for the best results the spark should be stopped before expansion of the discharge channel causes loss of power density, cooling, and a slower rate of metal removal. The electron avalanche strikes the anode before the positive-ion avalanche, with its much higher energies, reaches the cathode, so early ending of the spark is important, too, in keeping tool wear to an minimum.

ECAM sparking in the electrolyte.

There is something fascinating about predictions. Soothsayers, tea-leaves and crystal balls have gone out of fashion: they don't seem to have a sufficiently solid scientific basis. In their stead, we now have the long-range weather forecast. That has facts, equipment and scientific study to back it up — and 'statistics' to blame its errors on. An unbeatable combination!
Something else is required to satisfy the craving for really long-term prophesy. The best solution so far seems to be science fiction. Best-selling authors often have a scientific background, and they do their utmost to get their facts right — or at least ensure that the 'facts' in the story are not at odds with current scientific certainty. Furthermore, they have two good escape routes from the danger of making incorrect predictions: they can situate the story so far in the future that they won't be around when the complaints arise, and they can claim that it was all just done 'in the interest of making a good story'.
Then there is a third category: journalism in general, and magazine editors in particular. Come January — certainly at the beginning of a decade — and the floodgates are opened. This article is one of those . . .

coming soon?

this year — next year — sometime — never?

In this third category, the 'solid scientific foundation' is more tenuous than that of the weather forecast, but more solid than that of science fiction — at least, it ought to be. As in all three types of prediction, errors are possible — likely, even. Fortunately, there is an almost perfect escape: selective memory. Ten years from now, we may remind you of our correct predictions; but we will all have forgotten how wildly wrong we were on other points. Meanwhile, we can enjoy our phantasy game!
Actually, it is sheer coincidence that this article is in a January issue. It all started with a difference of opinion between two members of our editorial staff, in connection with the Digital Audio article elsewhere in this issue. When can we expect solid-state memories to replace records and tapes? 1990 or 2000? How fast are memories growing? The only way to find out is to check through our historical records, and attempt to evaluate the general trend. Along the way, we turned up quite a lot of dates that fascinated us. From that point, it was one small step: if we're intrigued, it's quite likely that our readers will be! Hence this survey: developments in electronics from 1870 to 2000.

Past history

Who made the first semiconductor diode? Mr. Braun, in 1874! It was known as the 'cat's whisker'. Who invented the tetrode? You'll never guess: Mr. Schottky! What were the first electronic computers like? Take ENIAC, in 1946: 18,000 valves, weighing 30 tons, power consumption 150 kW, clock frequency 100 kHz, filling a 30' x 50' room. It took nearly three seconds to multiply two ten-digit numbers. Compare that with today's pocket calculators!
A few highlights over the past century-and-a-bit are given in table 1. It is by no means complete: it merely reflects a few dates that struck us in the course of our browsing. One striking fact is that some ideas are much older than we thought (for instance, Baird demonstrated colour TV in 1928). Furthermore, the technological revolution is remarkably rapid, and it is speeding up! This may not be immediately apparent — we have become used to rapid development — but just think how long it took to progress from the wheel to the steam engine! Then compare that with the progress from Edison's tin-foil-cylinder phonograph (1877) to Sony's flat-screen pocket TV in 1982 . . .
Even within the last century, accelerated development is apparent. It took about a decade from the triode (Lee de Forest, 1906) to the tetrode (Schottky, 1919), the pentode (1929, Holst and Tellegen), and the beam tetrode (1936). It took less than five years from the germanium diode (mid '40s) to the transistor (1948, Bardeen, Brittain and Schockley), the IC opamp (early '50s), and the thyristor, FET, tunnel diode and mesa transistor (1957/1958).
Initially, it took one year to halve the price of basic four-function pocket calculators: $ 395 in 1970, $ 199 in 1971, $ 99 in 1972, through to $ 5.99 in 1976. To put it another way: it took about thirty years to shrink a 30 ton monster (ENIAC) into a far superior pocket-sized machine (Hewlett-Packard's HP-65: the first programmable pocket calculator, introduced in 1974, for $ 795). And it took less than twenty years to progress from the first mass-produced mini-computer costing less than $ 20,000

Table 1. A few highlights over the last century-and-a-bit.

year	components	audio	radio/TV	computers
1870-1880	cat's whisker diode	telephone (Bell), phonograph (Edison)		
1880-1890		stereo PA	Nipkow 'Telescope'	
1890-1900		disk record	transmission (Marconi)	
1900-1910	triode		crystal receiver	
1910-1915				
1915-1920	tetrode	capacitor mike	superhet, SSB	flip-flop circuit
1920-1925		tone control		
1925-1930	pentode	negative feedback, crystal pickup	TV broadcast, colour, stereo TV, large screen	
1930-1935		hi-fi, vinyl disc, 33⅓ RPM, juke box, moving coil mike	FM, UHF, PLL circuit	
1935-1940	beam tetrode J-FET theory			Boolean logic applied, Bell Model I relay comp.
1940-1945		tape recorder		Model III relay comp.
1945-1950	Germanium diode, transistor, p.c.b.	33⅓ and 45 RPM commercial discs		ENIAC
1950-1955	IC opamp			IBM 701, magnetic core
1955-1960	thyristor, FET, tunnel diode, mesa	stereo disc, 4-track tape	colour video tape deck	FORTRAN
1960-1963	planar, epitaxial, RTL, TTL, MOSFET, LED, MOS IC, Gunn diode			
1963-1966	DIP package, μA 709			PDP-8
1966-1970	1 K ROM	cassette-recorder		PDP-11, hand-held calculator
1970-1973	2 K EPROM			8-bit CPU
1974	4 K dyn. RAM			Josephson switch, programmable calculator
1975				
1976			video disc	16-bit CPU
1977	16 K dyn. RAM			TRS-80
1978				
1979	64 K dyn. RAM 64 K EPROM			
1980	64 K stat. RAM			
1981	256 K dyn. RAM			
1982			flat screen pocket TV	

1

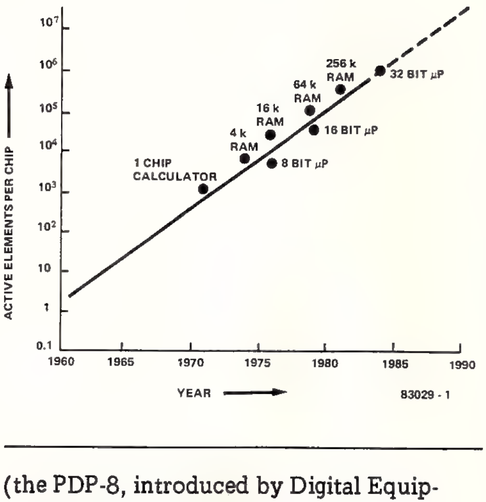


Figure 1. The number of active elements on a chip is increasing by an order of magnitude every five years, and there is no sign that this is slowing down. Within a year or two, that should lead to the 1 Mbit dynamic RAM — or a 16-bit processor with 16 Kword on-chip RAM!

(the PDP-8, introduced by Digital Equipment Corp. in 1965) to today's TV games computers, hand-held chess sets and low-cost personal computers (like the ZX 81).

Let's plot a few trends. Figure 1 shows the increase in the number of active elements per chip, from Fairchild's RTL flip-flop in 1961 to Hewlett-Packard's recent 750,000 transistor monstrosity. If this trend continues for a few years, we should hit 10^7 active devices by 1990. Given one device per memory cell, with a few spare for testing and internal organisation, this would mean 9 or 10 Mbit RAMs. WOW! In the year 2000, assuming the same trend, we'd be hitting 3 Gbit or so. Enough for 30 minutes of digital audio recording on one single chip! And that's not allowing for increasingly fast progress in technological development; a fair assumption on the short term, it would seem.

Talking about digital audio: what about playback-only? In current technical terms: what about ROMs? In some ways, ROM technology seems to be lagging. Given the same rate of progress as RAMs, EPROMs and such, we should have 1 Mbit ROMs by now (the 1 K ROM was introduced in 1968). In essence, a ROM cell needn't be larger than the area of two crossing minimum-width conductors on the chip; currently, that means approximately 1 μm. Even allowing for insulation and sophistication, 1 Mbit shouldn't be a problem. And the 'big shrink'

2

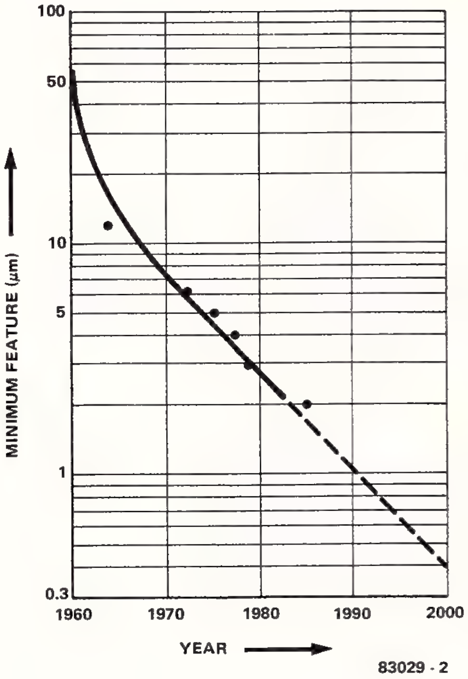
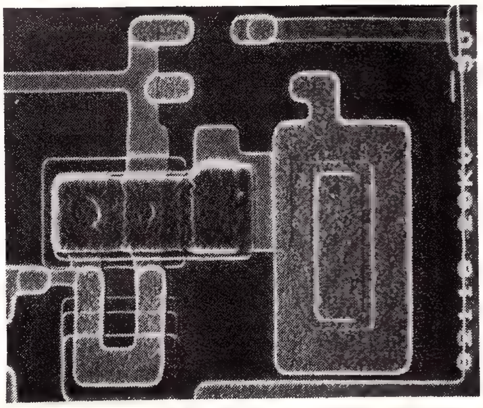


Figure 2. The big shrink. Despite the challenges associated with reducing the feature sizes in an integrated circuit, dimensions will continue to shrink. If minimum features follow the curve above, the 1 µm barrier for commercial devices will be broken within a decade.

is continuing: the prognosis given in figure 2 was released by IBM in 1980. This trend could mean that playback-only digital audio would be commercially viable in the 1990s.
Not to mention bubble memories. Admittedly, Intel seem to be the only people who are still active in this field. But they have already got a 4 Mbit bubble device! Promising . . .

Another point of interest is the development time from first prototype to commercially viable product. Colour TV was proposed in 1928; NTSC dates from the late 40s. 33⅓ RPM records were tried in 1931; the real start was in 1948. There is a distinct lag . . . The first Josephson switch was demonstrated in 1974; the switching time (80 picoseconds) was too fast to measure at the time. Add 10 or 15 years: an operational Josephson computer should be demonstrated sometime between 1984 and 1989 . . . Coming soon!



An experimental Josephson device.

Computer chronology

The rapid development of computers seems to have taken everyone by surprise – from scientists to science-fiction authors. This can be illustrated by means of a brief historical survey:

pre-1940: Mechanical computing machines existed; science fiction was more interested in robots, blandly assuming that they would be intelligent enough. In 1937, Shannon explained how Boolean logic could be applied to complex switching circuits, and in 1939 Bell labs built their Model I relay computer.
1944: The Bell labs Model III relay computer; it used 9000 relays, occupied 1000 squ.ft. and weighed approximately 10 tons. A 7-digit addition took 0.3 s.
1946: ENIAC, the Electronic Numerical Integrator And Computer, used 18,000 valves. It was a size bigger, filling a 30' x 50' room and weighing in at 30 tons. The power consumption was some 150 kW! It worked in decimal, adding 10-digit numbers in 0.2 ms (the clock frequency was 100 kHz). Multiplication took longer: 2.8 s.
Around this time, an extremely daring prophesy was made: it seemed conceivable that there might come a time when two computers would be needed in the United States for non-military use: one on the West coast and one on the East coast . . .
1952: The IBM 701 incorporated a few semiconductors: 12,000 Germanium diodes, to be precise. With its 3000 valves, 1 MHz clock, 36-bit words and 2 K word memory, it could add in 62.5 µs and multiply in 50 ms.
A few visionary SF authors were beginning to think in terms of Multivacs and Univacs.
1956: IBM discovered that some users were having difficulty with programming. They invented FORTRAN.
1961: By now there are some 5000 computers in use in the USA. Reseachers postulate 'a possible future in which computational power will be available in a wall socket, like electrical power, or where every man who wants one can buy a small computer'.
Fairchild introduces the RTL flip-flop; TTL follows within the year.
1965: Digital Equipment Corporation launches the PDP-8: the first mass-produced mini-computer to sell for less than $ 20,000. In the same year, Gordon R. Dickson put his finger on one of the distinctive features of artificial intelligence: 'Computers don't argue'.
1967: The 64-bit ROM.
1968: The 1 K-bit ROM.
1970: The PDP-11, the first CPU (Intel's 4-bit 4004) and hand-held pocket calculators.
1971: The first 8-bit CPU, Intel's 8008, costs $ 200. The average instruction time is 30 µs.
1974: The Josephson switch operates with a switching time of 80 picoseconds, and 4 K dynamic RAMs are available. The simplest pocket calculators are going for about $ 20, and Hewlett-Packard introduces the first

programmable calculator (the HP-65) for $ 795.
1977: The TRS-80 is going for $ 600. For that, you get a Z-80 based machine with 4 K RAM, 4 K ROM, keyboard, 12" screen, and cassette recorder.
now: We have 256 K RAMs and ROMs, powerful CPUs with up to 750,000 active devices on a single chip – and a flat-screen pocket TV. We have talking chips and the first steps towards speech recognition and artificial 'sight'. And we are still plagued with 'SF' films showing computers as massive cabinets and consoles, with a multitude of flashing lights and Lissajous patterns.

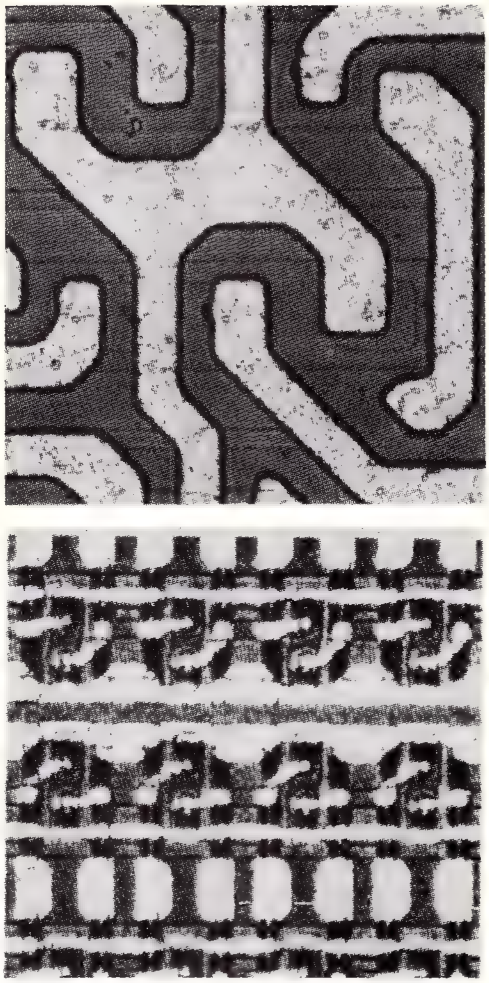
Coming . . . soon?

What can we expect in the next ten or twenty years? Based on past experience, it seems a fairly safe bet to start with a list of things that meet two requirements:

- available, or at least technically possible, now – even if the price is still astronomical;
- of great interest to a mass market, once the price drops far enough.

First, let's try to settle this digital audio question. Under the heading 'available now' we have ¼ Mbit RAMs and ROMs; for audio recording and reproduction we would need to use some 20,000 of these ICs (assuming that we need a playing time of one hour, in stereo). This would mean about four cubic feet and a price tag that puts the whole thing out of court. Good! That satisfies our first requirement.
The second point is even more obvious: there is a huge market for this type of thing. Any mechanical system is bound to be fairly clumsy and prone to wear. Wax cylinder, vinyl LP or Compact Disc: they will all attract an equal measure of nostalgic amusement in the museums of the future.

The remaining question is: when can we expect plug-in audio cartridges? Given the trend shown in figure 1, it should take another 15 or 20 years to develop multi-gigabit ROMs and RAMs. Add another five years or so for the price to drop to a competitive level, and we've reached the year 2005. However, there are a few factors that may help to speed things up. In the first place, we can use a different type of memory architecture (since we don't need full random access) and this may well simplify matters for the chip designers. Furthermore, we can get things rolling with smaller ICs: we can use several in one cartridge and we can start by replacing the 45 RPM disc – with its shorter playing time. Even a 10 Mbit ROM would do, and that may well be available by 1990! Again, add at least five years for the necessary price drop.
All in all, the sequence of events could be like this:
1990: RCA creates a world-wide sensation with its solid-state juke-box, the 'Byteryder'. Within a month, one of Hitachi's audio-minded daughters counters with a prototype 'Rombus' player.



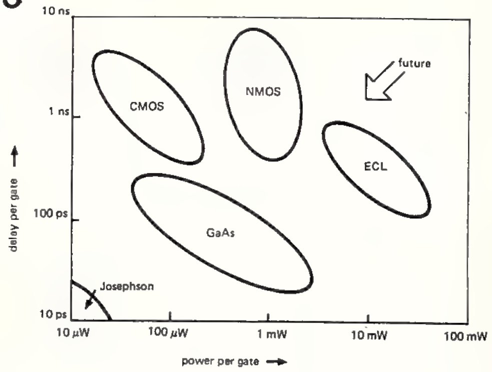
A decade of growth. Bipolar memories, like MOS ones, are on a track to higher density. One cell of Fairchild's 256-bit RAM (above), developed in 1970, occupies the same area as 16 cells of its 93470 4-K RAM (below). Scaled Isoplaner S will boost density another third.

1995: The first dust has settled. The leading manufacturers have reached agreement on the Compact Cartridge (although a few are still trying to perfect the Big Bubble). Pocket players are under development.
2000: With the price now at an all-time low, Compact Cartridge players are commonplace and recorders are available. The playing-time is still on the increase.
2005: Just as everything is settling down nicely, someone comes up with a new idea . . .

Computers

Again, it is wise to start with a brief review of our current assets. Powerful CPUs are available, large memories and all kinds of interfacing devices to the human operator. For displaying data: high-resolution TV

3



Gallium-Arsenide combines low power dissipation with a propagation delay that is an order of magnitude smaller than CMOS. The Josephson devices are that much faster again, and use only one-tenth of the power per gate!

screens on the one hand, and the pocket-sized type at the other end of the scale; printers in all shapes and sizes; and the first hesitant steps on the road to talking computers. Data entry by keyboard (mechanical or touch-pad); again, the first hesitant steps have been taken towards speech recognition and real-time entry by means of hand-written text. Communication with remote computers by telephone line – or by radio? Ultra-high-speed computers (using GaAs or Josephson devices), for applications that need them, are just over the horizon.

Let us assume that all these facilities are in full use within the next decade or so. What would that imply? Bearing in mind that human fingers are not likely to miniaturise in that period, things like a wrist-watch pocket calculator seem rather pointless.

A more sensible approach would be to develop 'handy' machines that are easy to use – even without having to study a 200-page manual.

For undemanding general-purpose use: the pocket computer. Data entry by means of a simple keyboard (numerical plus a few functions); data display via a miniature TV screen. Keying and programming errors are indicated in plain language on the display. The cheap plastic case is misleading: the computing power is superior to that of a 1975 minicomputer.

Home computers. The simpler types all tend to look similar, since their shape is determined by the keyboard and display screen. 'Under the bonnet', so to speak, they differ; however, they all include outputs for telephone line and large-screen TV sets. Also, for gimmick value more than anything else, they all include a 'speech' output that can ream off several dozen standard phrases.

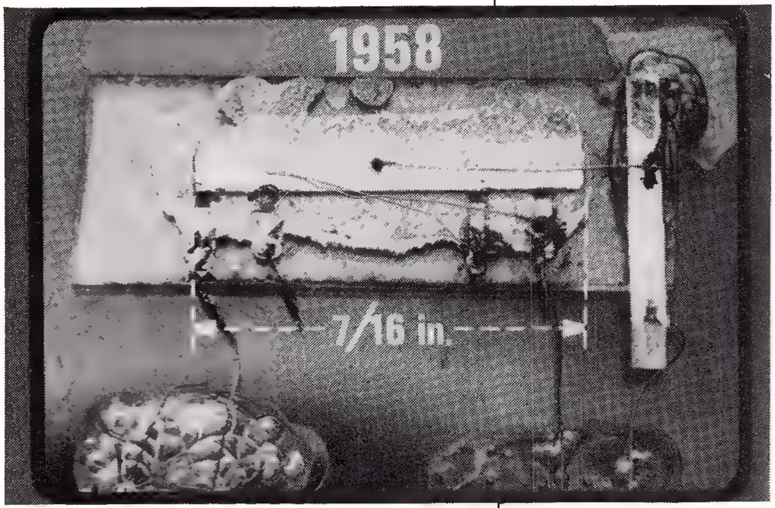
The de-luxe home computer is a different thing all together. It includes user-oriented features like speech input and output (in fact, the user will rarely feel the need to slide out the keyboard). The display screen has full-colour capability, and the speech output is extremely versatile. Furthermore, it is designed to deal with a host of 'domestic' matters on a continuing basis: light and heating control, routine cooking (and advice when you want to try something different), telephone answering and so on.

Computers for industrial and commercial use cover a wide range. Easy-to-use machines are available for routine work (speak-in typewriters, process controllers and industrial robots for mass production, answering machines for information services, etc.)

At the other end of the scale, high-speed computers with dual memories (mass data store and associative) are becoming the back-bone of scientific research and development. In fact, they are being used quite extensively . . . to develop even more futuristic computers!

Microprocessors? What an out-dated phrase! Those devices are everywhere, controlling everything from ovens to sewing machines to UHF tuners, mowing machines, electric drills and children's toys. They are nothing more nor less than common-or-garden electronic devices.

In the fifties, computers progressed from valves to transistors . . . .



. . . . then came the first integrated circuit. This has been shrinking, and the number of devices per chip has been increasing . . . .

What else?

All kinds of things. Put it this way: fifteen years ago, the pocket calculator was undreamed-of. Fifteen years from now, the undreamed-of may well be commonplace. Take it from there . . .

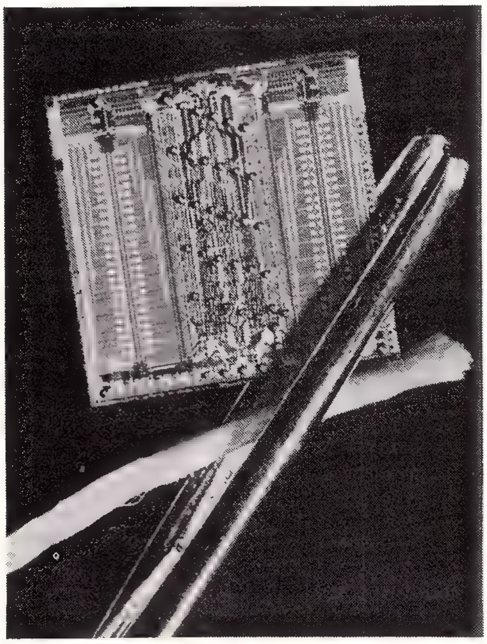
Electronic diaries with a perpetual calendar function.

Talking encyclopedias, with an optional print-out.

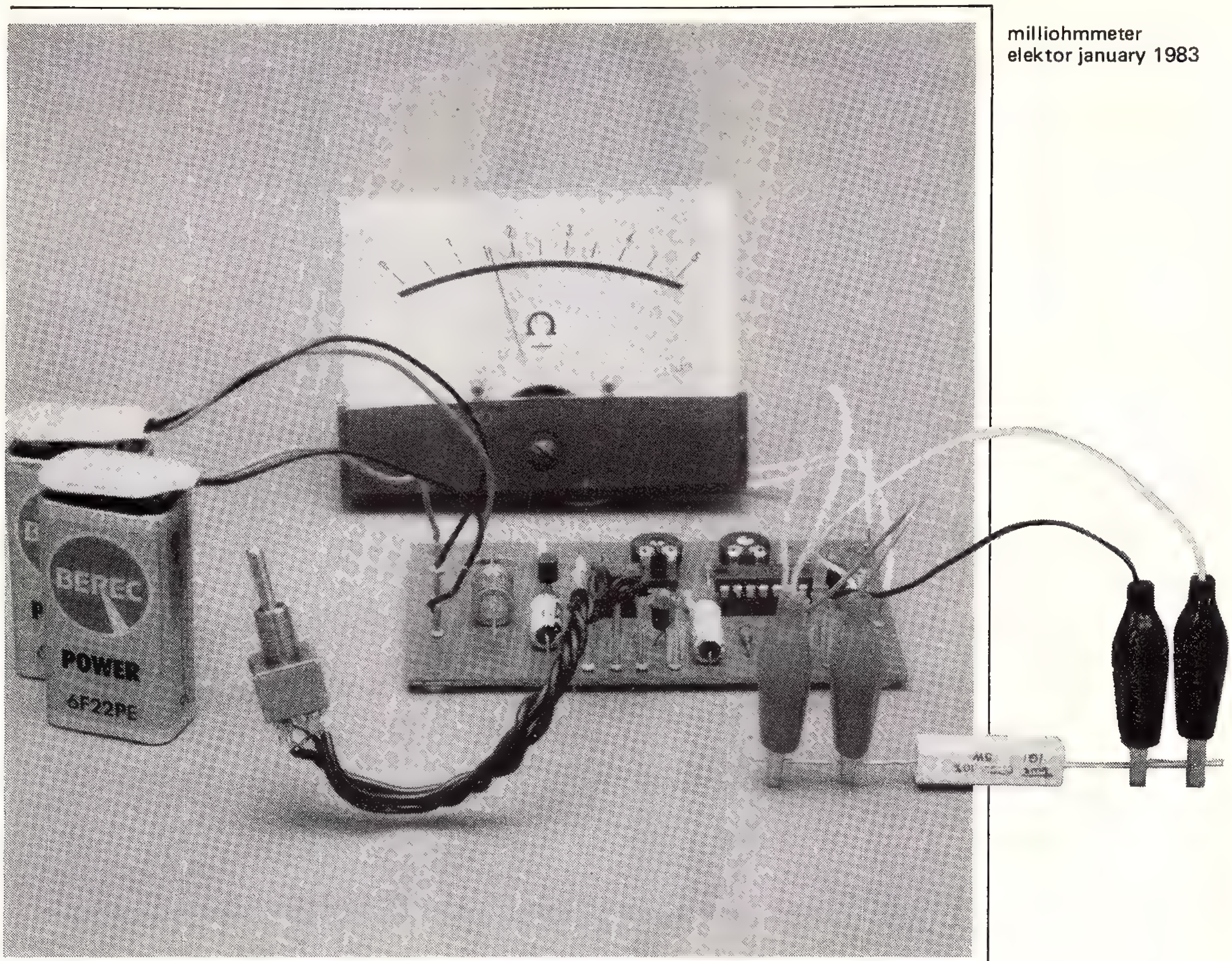
One-year-ahead weather forecasts.

Wrist-watch remote control units that double as car and front-door keys.

Elektor by telephone line.



. . . . until we get fairly modern memory chips like this one. Note that even this is no longer 'state of the art'!



milliohmmeter

a 'magnifier' for small resistances

With many of the digital multimeters used nowadays, the measuring of very small resistances in the milliohm range presents certain problems. With a 'full scale deflection' of 199.9 Ω, the display error after the decimal point can be 100%! This certainly leaves a lot to be desired.
For this reason, a more precise method must be applied when measuring the resistances of loudspeakers, coils, conductors (printed circuit board copper tracks) and the like. The lowest measuring range of the milliohmmeter is 0.5 Ω ±1% (full scale deflection), which gives us something to work with.

Let us assume that our digital multimeter has a lowest measuring range of 199.9 Ω ±1% deviation from the displayed value; the percentage with a displayed value of 0.1 Ω can be discounted, but the specified precision of ±1 digit means that the value read off can be 0.0 or 0.3 Ω. This corresponds to an inaccuracy of 100% and becomes unacceptable. Moreover, if one takes into account the contact resistance of the plug-in connectors, the measured value becomes totally unrealistic.
Figure 1 shows how these contact resistances become part of the measurement. The sketch also indicates the manner in which a resistance measurement is nor-

1

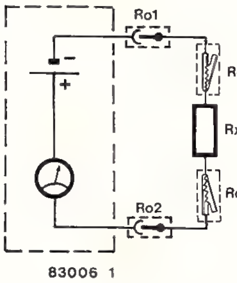


Figure 1. Using conventional resistance measurement, there are normally four contact resistances in series with the resistance to be measured.

mally performed. Resistance R_X to be measured is connected to the multimeter by means of two test leads. In series with R_X one therefore obtains four contact resistances: the plug-in connections to the instrument (R01 and R02) and the two clip-on connections between the test leads and the resistance (R03 and R04). Thus the value displayed by the instrument will be the sum of all contact resistances and R_X. No matter how precise the multimeter, if the value of R_X is very low than the displayed value bars no relation to the real value of R_X.

So what is the solution for obtaining reliable measurements? There is a well known measuring technique that can also be applied to measure very low resistances. The technique requires the use of a current source which provides a constant current that can flow through the resistance. The voltage over the resistance is measured with a voltmeter. Figure 2 shows a sketch of the principle. The voltmeter is connected directly across the resistance to be measured. The contact resistances R01 and R02, the 'previous' plug-in connections between the resistance and the multimeter, no longer contribute to the measurement. Neither do these resistances affect the 'measuring current' because the latter is kept constant by the current source. All that remains are the contact resistances R03 and R04. In relation to the internal resistance of the voltmeter, their values are so low that they can be ignored. We can therefore be satisfied that the contact resistances make practically no contribution to the resistance value measured using this technique.

Milliohmmeter adapter

Figure 3 shows a simple adapter based on the principle of the constant current source, which can be used to extend a standard multimeter into a milliohmmeter. One could call it a kind of 'magnifier'. From left to right, the circuit diagram contains a simple power supply, a voltage regulator IC 78L05 (IC1) which provides a stable supply voltage, and a current source which is based on IC2 and T1. The resistance to be measured R_X is connected in the collector line of T1. The multimeter (set to a d.c. voltage range) is connected in parallel with R_X (between the clips of the current source; see also figure 2). S1 is used to select one of two sensitivity ranges. When S1 is set to position C, the current source supplies a current of 100 mA. If a voltage of 10 mV can be read on the multimeter with sufficient accuracy, resistances down to 0.1 Ω can be measured. When S1 is set to position B the current through R is 10 mA. In this case, a reading of 10 mV on the multimeter corresponds to a resistance of 1 Ω.

This circuit can be assembled quite quickly on a piece of vero board. Precision resistors (1% tolerance) must be used for R3 and R4. T1 should be cooled on account of the high dissipation when 100 mA is drawn. Alignment is simple: set S1 to position B; substitute an ammeter for R_X and adjust P1 to obtain a current of exactly 10 mA.

2

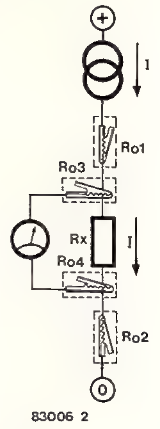


Figure 2. If a constant current flows through the resistance and the voltage across it is measured, the contact resistances have practically no effect.

De Luxe version

The only disadvantage with this method when measuring low resistances is that the set-up draws too much current. With a voltmeter sensitivity of 10 mV – or even better, 1 mV – resistances as low as 0.1 and 0.01 Ω respectively can be measured. The current required, however, is 100 mA which means that the circuit diagram of figure 3 is unsuitable for battery operation.

An efficient way of saving energy is to reduce the measuring time. Instead of passing a constant current through the resistance to be measured, short current pulses are applied. The disadvantage of this method is that inductive resistances, such as wire resistances, coils and transformer windings can no longer be measured accurately. Apart from this aspect, however, the pulse method offers considerable advantages when compared to the circuit of figure 3.

Figure 4 shows the block diagram for this method.

The current source is driven by an oscillator. Current flows through the resistance for 250 µs, followed by an interval of 25 ms. Although the measuring current during the pulse is 100 mA, this duty cycle results in an average current of only 1 mA.

The voltage peaks developed over the resistance are subsequently amplified by a factor of 100, so that their amplitude directly represents a measure of the value of the

3

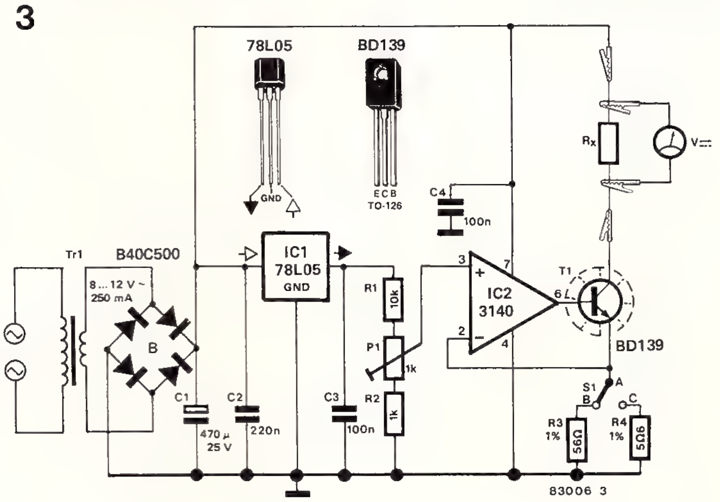


Figure 3. Complete circuit diagram of the milliohmmeter using the constant current source method.

resistance. All that is now required is that the pulses be processed into a measurable d.c. voltage. A simple sample-and-hold circuit was chosen and is represented by a switch and a capacitor in the block diagram. The switch is driven by the same oscillator which switches the current source on and off. With each pulse the switch closes immediately, feeding a voltage sample to the capacitor. The capacitor C_{HOLD} is therefore charged to the same amplitude as that of the corresponding pulse. The voltage value (stored) in the capacitor is then applied to the voltmeter via a buffer stage. The observant reader will have noticed that the negative terminal of the voltmeter is not connected to ground, but to the output of the amplifier. The reason for this is that temperature deviations can cause variations in the offset voltage of the amplifier, with the result that the zero level at point A is shifted. If the voltmeter is connected between the output buffer and ground, such a shift would immediately cause a measurement error. In our case, however, any such change in the offset voltage is harmless because the level at point B is shifted to the same extent as that at point A. Strictly speaking, point A should not be taken as the reference because the pulses delivered by the current source are applied to that point for 2.5 µs. However, the resultant measurement error is only 1% and is considerably smaller than that caused by component tolerances and lack of precision of the voltmeter. The measuring current can be increased by 1% in order to eliminate this error completely.

4

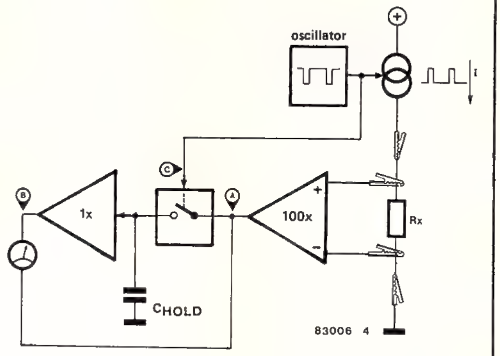


Figure 4. If the current source is switched by an oscillator, the current drawn by the circuit is restricted during the high measuring-current flow.

The circuit

Figure 5 shows the circuit diagram of the De Luxe milliohmmeter. The block diagram in figure 4 can easily be recognized here. A 7555 timer IC (IC3) with associated components serves as oscillator. The operating voltage for IC3 is stabilized by a

5

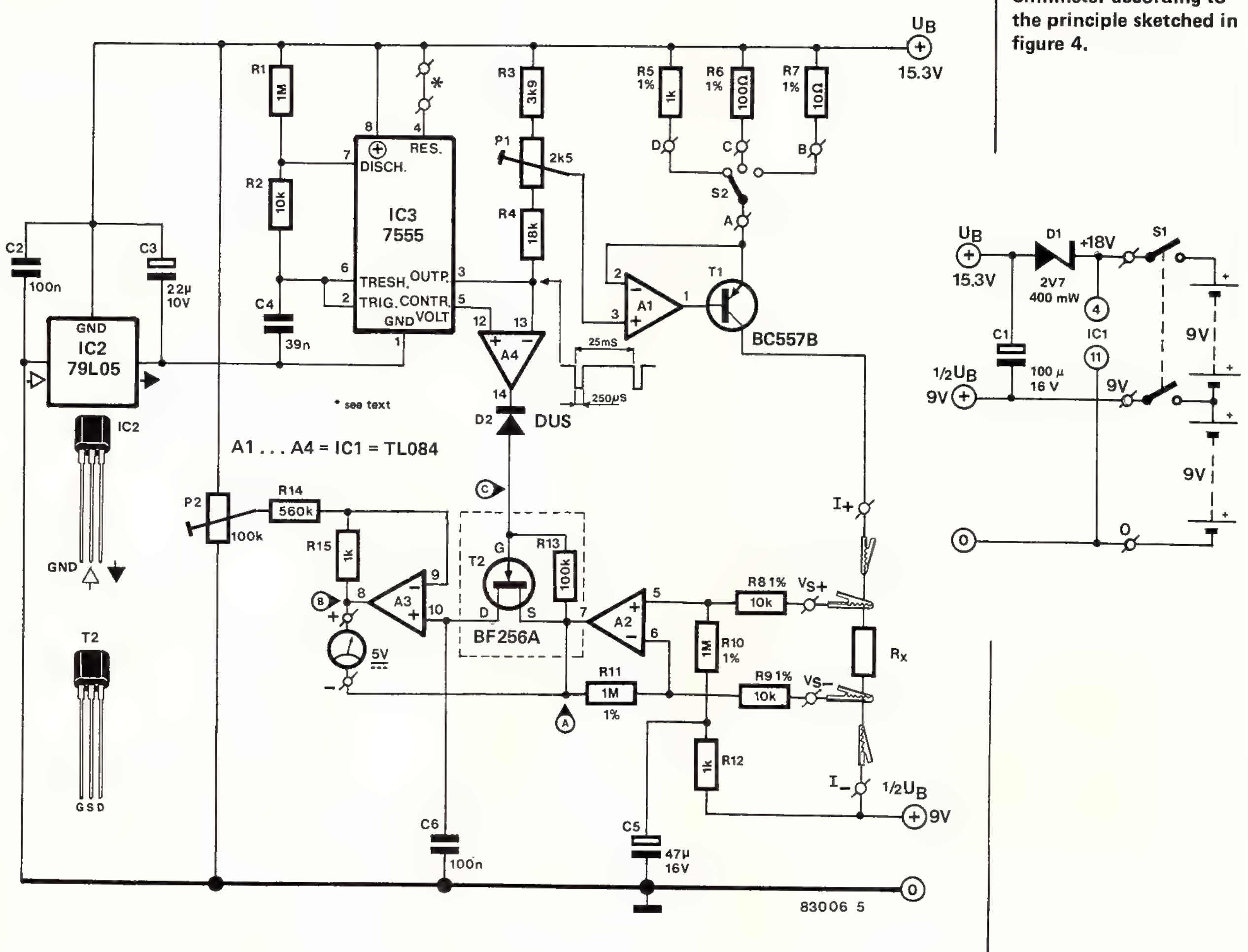


Figure 5. Complete circuit diagram of a milliohmmeter according to the principle sketched in figure 4.

6

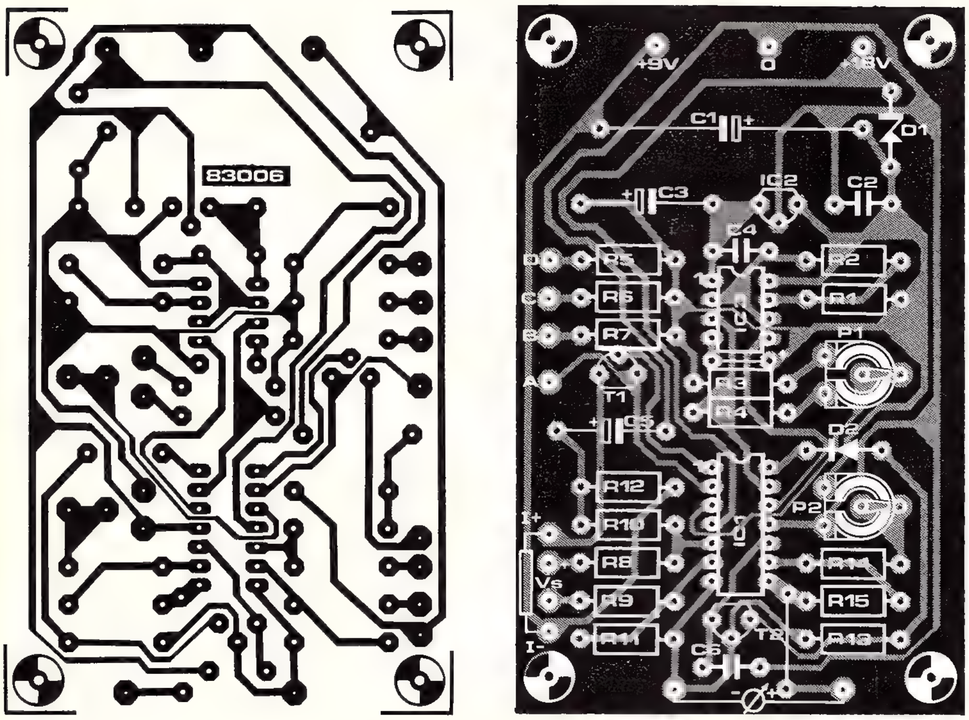


Figure 6. Track pattern and component layout for the circuit of figure 5. Terminal points I+, I−, U_{S+} and U_{S-} are connected by means of test leads to the resistance to be measured.

voltage regulator (IC2) to provide the necessary stability for the current source. The current supplied is proportional to the output voltage and is therefore also proportional to the operating voltage of IC3. The current source is composed of A1 and T1. Three different measuring currents can be selected with S2: 100 mA (position B), 10 mA (C) and 1 mA (D).

The voltage over the resistance to be measured R_X is picked off with two clips and applied to the amplifier A2 via R8 and R9. A BF 256A FET (T2) is the switch for the sampling circuit. This switch is driven by oscillator IC3 via A4. Capacitor C6 provides storage for the sample-and-hold circuit. The voltage at C6 is applied to the voltmeter via buffer A3.

Zener diode D1 ensures that the operating voltage of the operational amplifiers is somewhat higher than that of the rest of the circuit. In this way the outputs of the operational amplifiers can be fully driven to U_B, thus ensuring that the current source is switched off completely. The circuit is powered by two 9 V batteries, each supplying 10 . . . 15 mA. Variations in operating voltages have practically no effect on circuit operation. Even if the operating voltages drop to 6 V, the additional measurement error is only 0.3%. We are referring to 'operating voltages' here, because two fresh batteries must be used from the start. Incidentally, as the batteries become discharged the drop in voltages has a negative effect. The drive range becomes smaller. At an operating voltage of + 6 V the value of the maximum resistance to be measured in the 1 mA range is only 40 Ω instead of 50 Ω.

Construction and alignment

Construction of the circuit should present no problems using the printed circuit board of figure 6. Terminal points are marked, thus facilitating the connections between the board and the batteries, multimeter and so on.

Two points require particular attention. Switch S2 should be a type exhibiting the lowest possible contact resistances. A poor switch contact will cause an incorrect measuring current, particularly in the 100 mA range.

The second point concerns the test leads. To avoid confusion the four different leads should have different colours: for instance, red for I+, orange for U_{S+}, black for I− and brown for U_{S-}. The I-clips are connected to the resistance and the U_S-clips are also connected directly to the resistance, thus keeping contact resistances as low as possible.

Calibration is relatively simple:

- Remove the wire link marked *; connect pin 4 of IC3 to pin 1 of IC3 and set S2 to position C (10 mA).
- Connect an ammeter between I+ and I− and adjust P1 for exactly 10 mA.
- Reconnect the wire link.
- Short-circuit U_{S+} and U_{S-} and connect to $U_B/2$ (= U_{S-}).
- Connect a voltmeter (multimeter) and adjust P2 for exactly 0 (mV).

Parts list

Resistors:

R1 = 1M
R2 = 10 k
R3 = 3k9
R4 = 18 k
R5 = 1 k/1%
R6 = 100 Ω/1%
R7 = 10 Ω/1%
R8,R9 = 10 k/1%
R10,R11 = 1 M/1%
R12,R15 = 1 k
R13 = 100 k
R14 = 560 k
P1 = 2k5 preset
P2 = 100 k preset

Capacitors:

C1 = 100 μ/16 V
C2,C6 = 100 n
C3 = 22 μ/10 V
C4 = 39 n
C5 = 47 μ/16 V

Semiconductors:

D1 = zener diode 2V7/0.4 W
D2 = DUS
T1 = BC 557B
T2 = BF 256A
IC1 = TL 084
IC2 = 79L05
IC3 = 7555

Miscellaneous:

S1 = double-pole on/off switch
S2 = rotary switch, 3 positions, 1 contact

the accessories for the
Crescendo
elektor january 1983

accessories for the Crescendo power amplifier

countdown and d.c. protection circuit

The second part of the Elektor audio XL system contains the protection circuits for the Crescendo power amplifier. A good power amplifier must be capable of operating under all circumstances, and the Crescendo is no exception. There are some signals, however, which can damage the loudspeakers: these are mainly activation peaks (inrush surges) and d.c. voltages. To protect the loudspeakers from these hazards, every power amplifier should be equipped with d.c. protection with built-in power-up delay. These are the functions of the accessories for the Crescendo, which are also suitable for other amplifiers.

Elektor readers who are hi-fi enthusiasts will no doubt have read the Crescendo article in the December 1982 edition. Some will already have started building the power amplifier. Once constructed, tested and installed in an attractive cabinet, the amplifier should operate reliably and with consistent quality for years. However, there is always a chance that a component will fail in the course of time or that some other malfunction will occur. In such cases, for example, it is possible for a d.c. voltage to reach the amplifier outputs and destroy the expensive loudspeakers.

The latter are simply not designed to cope with this eventuality. Moreover, problems can occur when the amplifier is switched on and off. It is quite normal for a complicated circuit, such as that of a power amplifier, to require a certain time to settle down after the operating voltage has been switched on. Once all components have reached their operating temperatures, it can be assumed that the d.c. levels in the circuit are stable. When the operating voltage is switched off, there is no way of being certain how the circuit will respond. Finally, irritating sounds such as pops can be heard from the loudspeakers when the amplifier is switched on and off. These sounds are not necessarily hazardous to the loudspeakers but are usually unwanted! For this reason, high-quality commercial amplifiers almost always contain protection circuits to protect the expensive loudspeakers from power-up and turn-off peaks and unusually high d.c. voltages at the output. Obviously the Crescendo power amplifier also contains fuses, because an excess of a.c. can result in an excess of d.c.!

It is clear, therefore, that the Crescendo (and any other home-constructed amplifier without an output capacitor) should be equipped with such protective circuits. The circuit presented in this article performs two functions: firstly, it connects the loudspeakers to the amplifier outputs by means of a relay, exactly five seconds after switch-on. Secondly, it continuously monitors for an excessive d.c. voltage at the outputs. If this voltage exceeds a particular value, the links between the amplifier and the loudspeakers are disconnected. The operating voltage for the protective circuit was chosen so that the relay is immediately de-energized after the mains supply has been switched off. Although the Crescendo is still subjected to decaying voltages as a result of the large smoothing capacitors, the loudspeakers are safely disconnected.

The delay circuit also contains a special feature: during the warm-up time of the amplifier the five-second countdown can be observed on an LED 7-segment display. One can therefore see when the loudspeakers are connected.

The circuits

Shown in figures 1 and 2 are the power-up delay and the protection circuits. In principle, both circuits can be incorporated separately. The only section which is common to both is the relay stage with Re1, D13, T5, T6 and R23.

The delay with its down-counter chiefly consists of ICs 1 . . . 4. IC2 is a programmable up/down counter with presettable parameters. The parameter is set to 5 by means of the J-inputs in this case. The device is also configured as a down-counter (pin 10 to ground). The clock input of this counter is driven by a square-wave generator consisting of N1, C1 and R1. When the operating voltage is switched on, IC2 is first provided with a preset pulse via network R2/C2. The value 5 is then 'present' in the counter. The square-wave generator then starts operating so that a clock pulse is applied to IC2 every second. When the counter contents become zero (5 seconds after activation), the $\overline{\text{carry-out}}$ output of the counter emits a logic 0, with

1

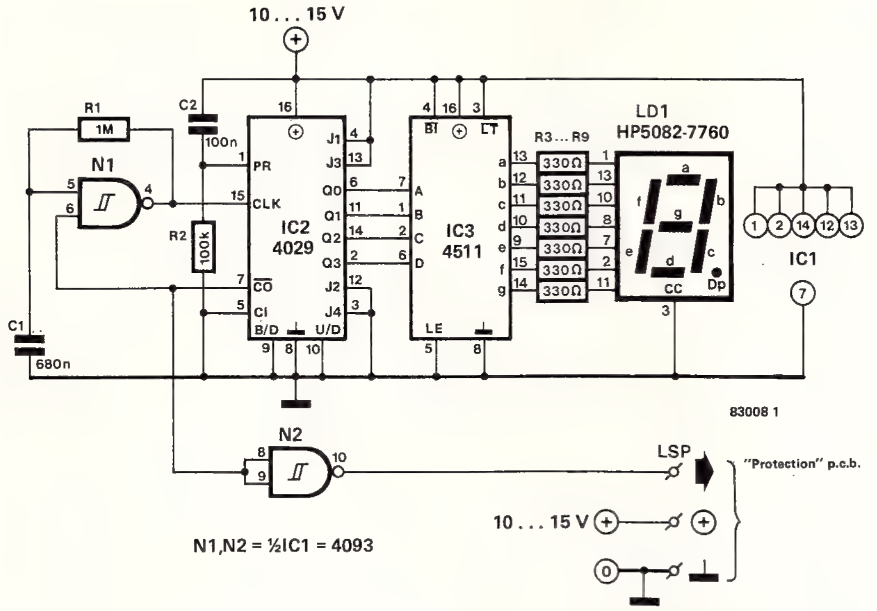


Figure 1. This part of the circuit provides the power-up delay. The time remaining until switch-on is displayed as a count-down.

2

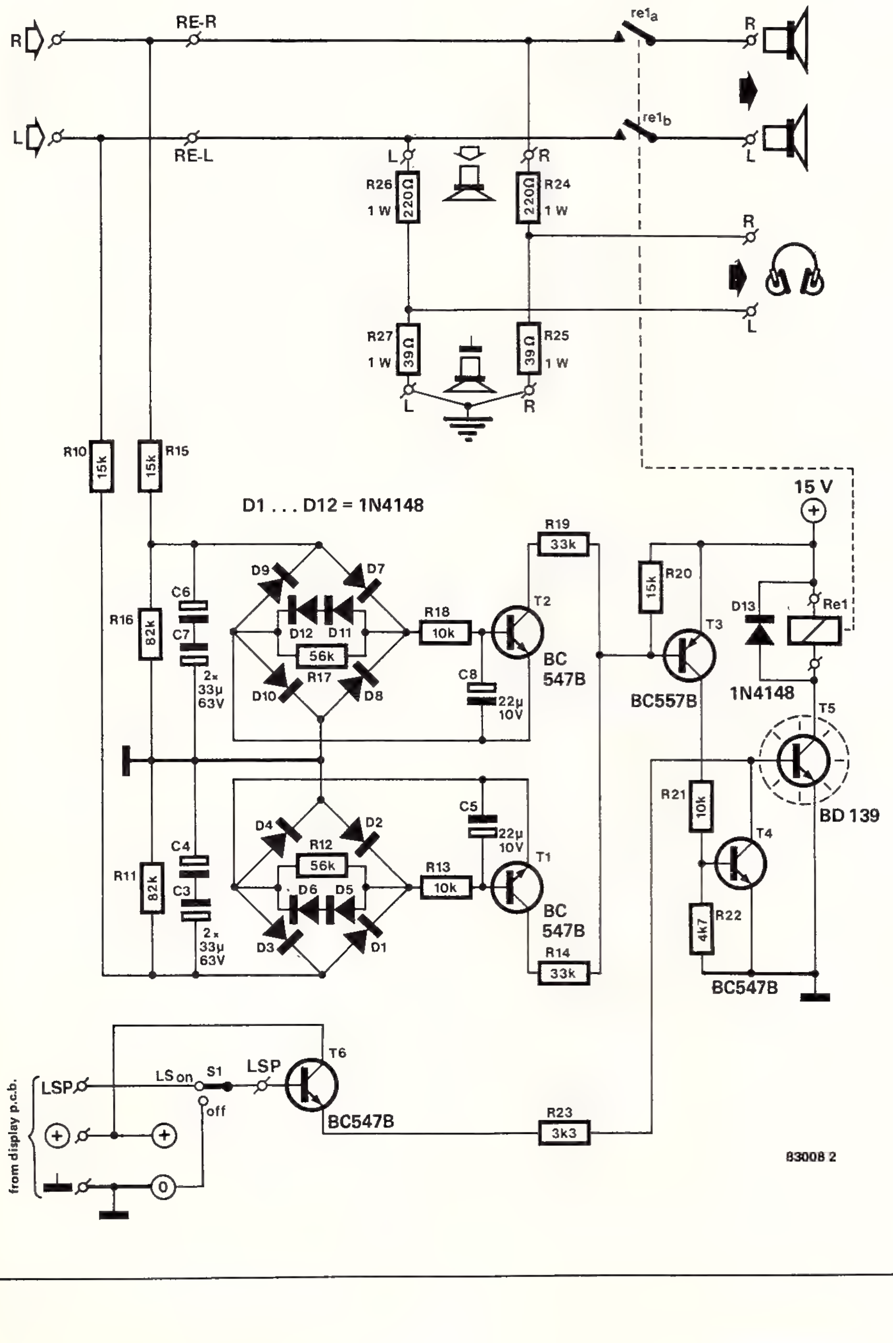


Figure 2. The d.c. protection circuit, protects the loudspeakers from hazardous d.c. voltages.

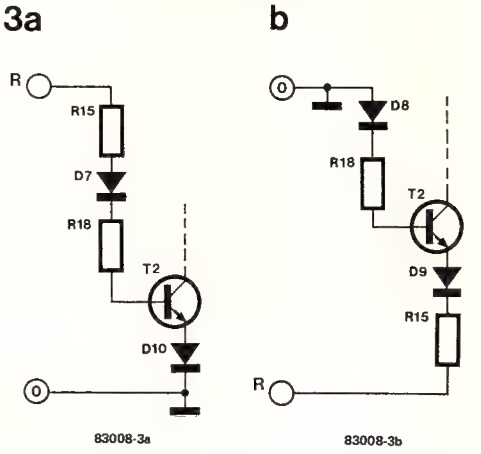


Figure 3. This figure shows the signal paths for positive d.c. voltages (figure 3a) and negative d.c. voltages (figure 3b) at the inputs of the circuit. Only the right-hand channel is shown here.

the result that the square-wave generator is inhibited and the counter stops at zero. The carry-out output therefore activates the relay via N2 and transistors T5 and T6 (in figure 2). The loudspeaker outputs are thus connected to the amplifier outputs.

The down-counting from 5 to 0 is visible on the LED display LD1. IC3 is a BCD-to-7-segment decoder/driver which can directly drive an LED display. Thus, only resistors R3 . . . R9 are required for connection of the display. In this way, the contents of counter IC2 are displayed by IC3 and DP1.

The d.c. protection circuit is shown in figure 2. As already mentioned, the task of this circuit is to disconnect the loudspeakers if a d.c. voltage appears at one of the amplifier outputs. The detection part of this circuit is configured separately for each channel. This prevents a positive error voltage at one output from compensating for a negative one at the other output, which would be the case if both outputs were connected to only one detection circuit by means of two resistors. Each detection circuit consists of a lowpass filter, a bridge rectifier and a transistor configured as an electronic switch. The lowpass filter prevents the circuit from reacting to frequencies which are normally processed by the amplifier. For this reason, each amplifier output is first followed by a 12 dB/octave filter with a cutoff frequency of approximately 0.5 Hz. For the left channel the filter consists of R10, C3/C4, R13 and C5, and for the right channel R15, C6/C7, R18 and C8. Resistors R11, R12, R16 and R17 also have a negligible effect on the filter. R10 and R11 form a potential divider to keep the maximum voltage across capacitors C3 and C4 below the 63 V working voltage. This is because in the event of a fault, the power amplifier can present a maximum d.c. voltage of 75 V at its output. R15 and R16 perform the same function in the other channel. Resistors R12 and R17 serve to discharge C5 and C8. Otherwise the capacitors would remain charged, on account of the diodes.

D.c. voltages are detected as follows. The sketch in figure 3 shows which components conduct in the event of an excessive positive d.c. voltage (3a) and an excessive negative d.c. voltage (3b). For the sake of clarity, only the right-hand channel is shown here and components not required for this explanation have been ommited. In figure 3a it can be seen that diodes D7 and D10 and the base-emitter junction of T2 are in series with resistors R15 and R18. This means that the transistor is driven if the voltage at the input is more than three diode voltages. In practice, the input voltage must be somewhat higher to turn T2 on fully. The voltage drop over R15 and R18 must also be taken into account, when a base current for T2 is flowing. Thus, T2 switches when subjected to a positive input voltage of slightly more than 3-times 0.7 V = 2.1 V.

With a negative voltage at the input, we have the situation in figure 3b. Here too, three diode junctions must be overcome for T2

4

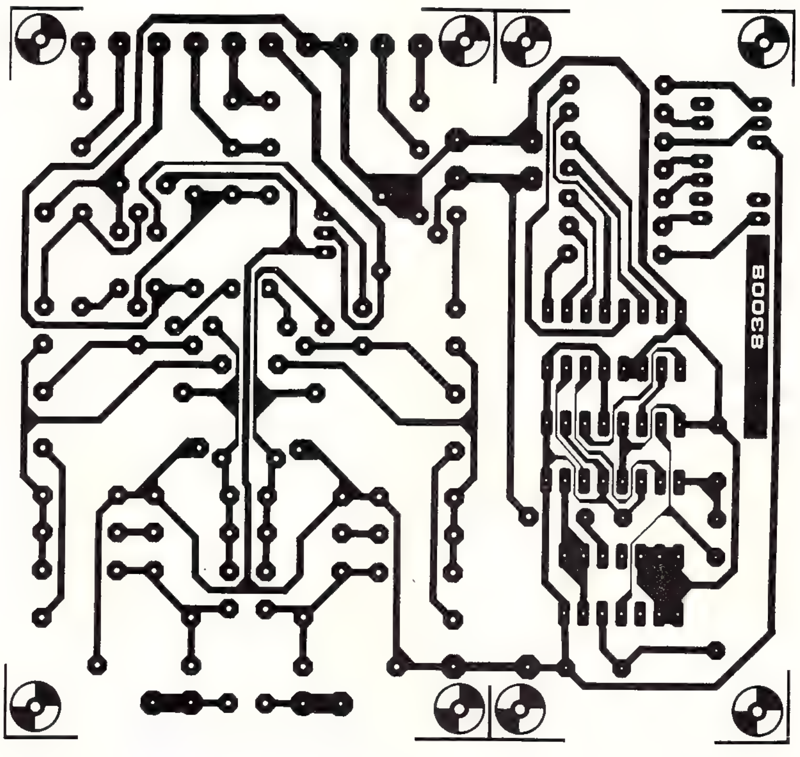


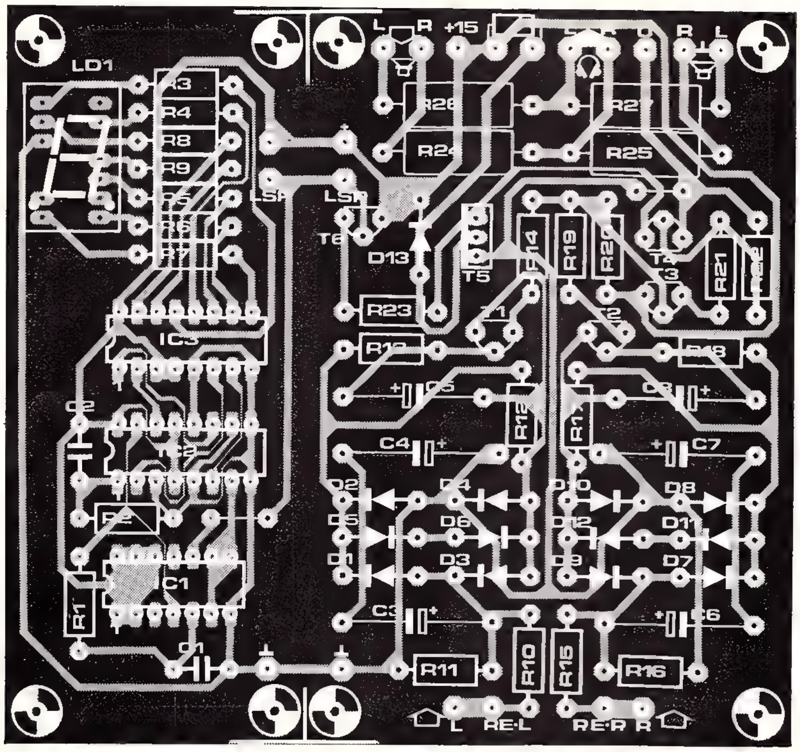
Figure 4. The printed circuit board consists of two parts: a display part and a protection part. The two can be separated if desired.

to conduct. One could assume that the same (negative) voltage must be overcome here as in figure 3a. However, this is not quite right. The input voltage must be somewhat higher because the collector current is flowing through R15 in addition to the base current. Thus the voltage drop over this resistor is somewhat higher than that with a positive input voltage. In practice, the circuit responds to negative voltages of approximately 2.6 V and higher.
The parallel circuit of D11/D12 and R17 is connected between D7/R18 and the emitter of T2. The two diodes ensure that the base current of T2 is limited to a safe level, when high d.c. voltages are applied to the input of the circuit. As already mentioned, R17 serves to discharge electrolytic capacitor C8. The circuit for the left-hand channel functions in the same way.
The collectors of the switching transistors are connected to the base of T3 via R14 and R19. R20 ensures that T3 does not fail to turn off, even if T1 and/or T2 should exhibit slight leakage current in the off-state. Transistor T4 is connected to the collector circuit of T3. Transistor T4 provides isolation for the base current supplied by T6 for T5, when the protective circuit responds. If T1 and/or T2 conducts because of a d.c. voltage at one or both inputs, T3 conducts. In this case, T4 conducts also and the BD 139 power transistor is starved of base current. The relay in the collector circuit of T5 is de-energized and the links between the loudspeakers and the power amplifier are disconnected.

The circuit also contains four resistors for matching a set of headphones to the power amplifier. This allows the headphone outputs to be tapped at the amplifier outputs. If the listener only wishes to use the headphones, the loudspeakers can be switched off by means of S1. Those readers desiring separate headphone amplifiers will find relevant information in a future article to be published (preamplifier for the audio XL system). In this case, resistors R24 . . . R27 and switch S1 are not required.

Construction and installation

Figure 4 shows the track pattern and component overlay for the printed circuit board. The printed circuit board was designed to consist of two parts which can be separated if desired. This makes it possible to mount the display part in the front panel of the power amplifier housing and the part containing the remaining circuitry elsewhere, preferably directly at the loudspeaker outputs (i.e. the point where the relay should also be installed). The display printed circuit board can also be installed in the preamplifier housing and the 'protection part' in the power amplifier. This feature should be of interest to those readers wishing to conceal their power amplifier (for example, immediately behind the loudspeaker boxes). When separating the board, it should be noted that three wire links must be connected: LSP, + and '⊥'. If it is not separated, of course, these links will not be needed. If the headphone output is connected, switch S1 must be incorporated in the LSP link with the first arrangement. In the second case, the appropriate track should be cut so that the switch can be connected at this point. Constructors wishing to limit themselves to a more modest budget may prefer the following alternative. In this case, the display part is entirely omitted; a 33 k resistor is connected between points '+' and LSP and an electrolytic capacitor (47 µ/16 V) and 100 ohm resistor in series are connected between points LSP and '⊥'. Here too, S1 can be utilized. If one wishes to have a 'digital' delay time in any case,



Parts list

Resistors:

R1 = 1 M
R2 = 100 k
R3 . . . R9 = 330 Ω
R10,R15,R20 = 15 k
R11,R16 = 82 k
R12,R17 = 56 k
R13,R18,R21 = 10 k
R14,R19 = 33 k
R22 = 4k7
R23 = 3k3
R24,R26 = 220 Ω/1 W
R25,R27 = 39 Ω/ 1 W

Capacitors:

C1 = 680 n MKT
C2 = 100 n MKT
C3,C4,C6,C7 = 33 µ/63 V
C5,C8 = 22 µ/35 V

Semiconductors:

D1 . . . D13 = 1N4148
T1,T2,T4,T6 = BC 547B
T3 = BC 557B
T5 = BD 139
LD1 = 7760 (common cathode)
IC1 = 4093
IC2 = 4029
IC3 = 4511

Miscellaneous:

Re1 = relay 10 . . . 15 V/ 50 . . . 100 mA,
2 normally-open contacts 10 A_{rms} gold-plated

5

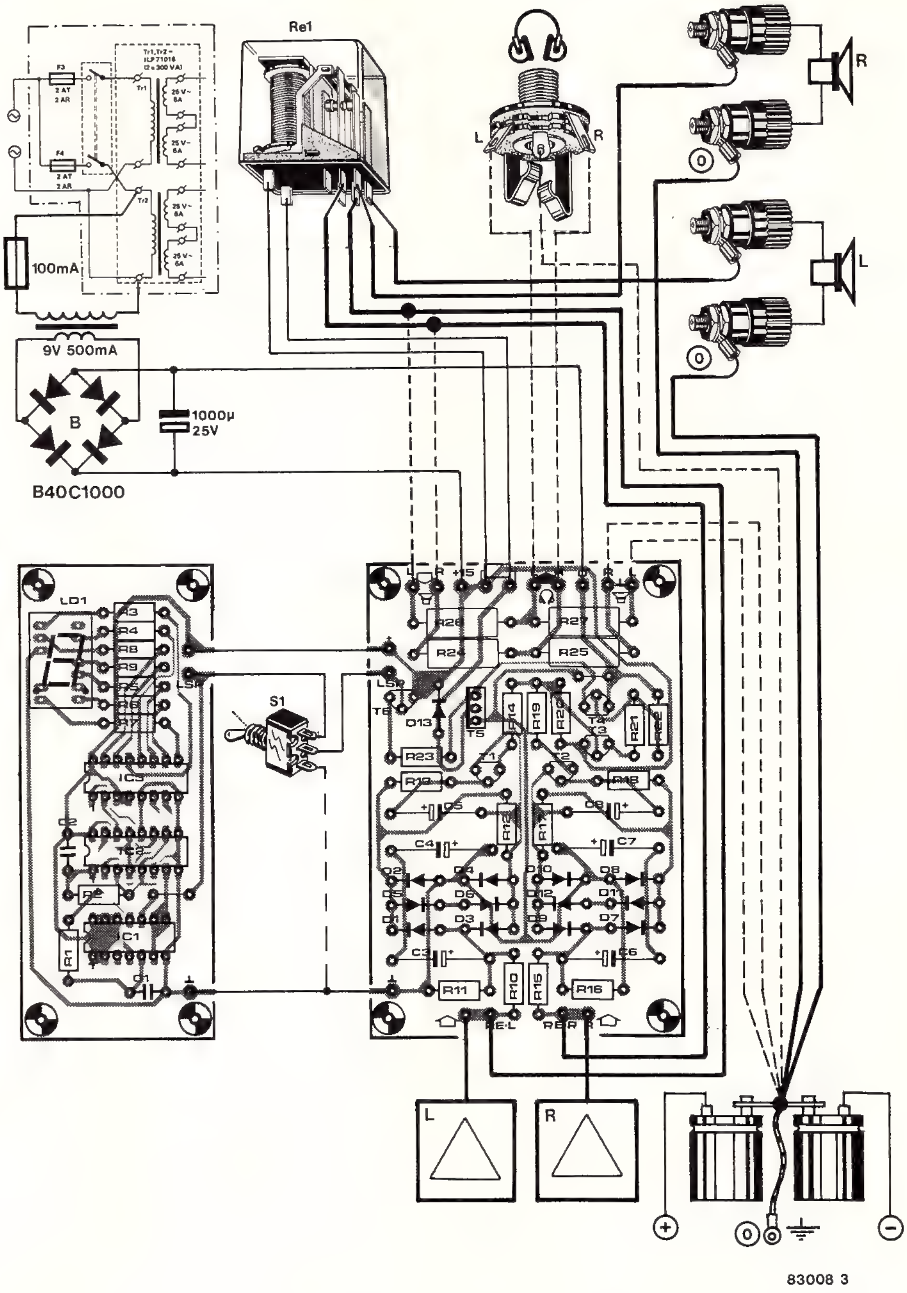


Figure 5. This is the wiring diagram. The leads drawn with dashes relate to the headphone outputs.

only IC3, LD1 and R3 . . . R9 are omitted. The relay must be rated for a coil voltage of 12 V and must be capable of switching a *minimum* of 5 A per contact. It is well worth procuring a relay with goldplated contacts.

Connections are made in accordance with figure 5. In our example, we have assumed that the display section is separate from the main board and switch S1 is inserted.

The relay must be installed in the immediate vicinity of the loudspeaker outputs of the amplifier. This is also preferable with the protection circuit. The purpose of S1 is to switch off the loudspeakers by means of the relay, if the listener only wishes to use the headphones. The leads drawn with dashes can be omitted if the headphone output will not be installed. In this case, S1 and R24 . . . R27 are also omitted.

Under no circumstances should a large electrolytic capacitor be utilized.

After switching on the operating voltage the display shows the countdown from 5 to 0. Once the figure 0 appears on the display the relay will be energized and the display should continue to show 0. As a functional check, a 4.5 V flat battery is connected to the input for the left channel with positive to the input and negative to the circuit ground. The protection circuit should respond and the relay should be de-energized again. Remove the battery. After a short time the relay will be energized again because the fault at the input will have been eliminated. Now connect the battery with inverse polarity and the relay should be de-energized once again. This procedure should be repeated at the input for the right-hand channel.

It can now be assumed that the loudspeakers are effectively protected against surges, peaks and d.c. voltages at the outputs of the power amplifier. ◄

darkroom computer tips

with a contribution from H. Fietta

The many reactions to the darkroom computer described in the September and October 1982 issues are evidence of the great interest shown in this circuit. This article now describes the manner in which the darkroom computer can be connected to the well-known Philips enlargers PCS 2000 and PCS 130/150. Also shown is a method of obtaining better linearity of the thermometer, as well as an improvement to the operation of the darkroom computer by means of a small program modification.

1

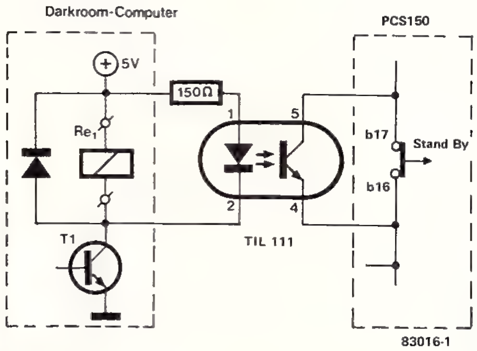
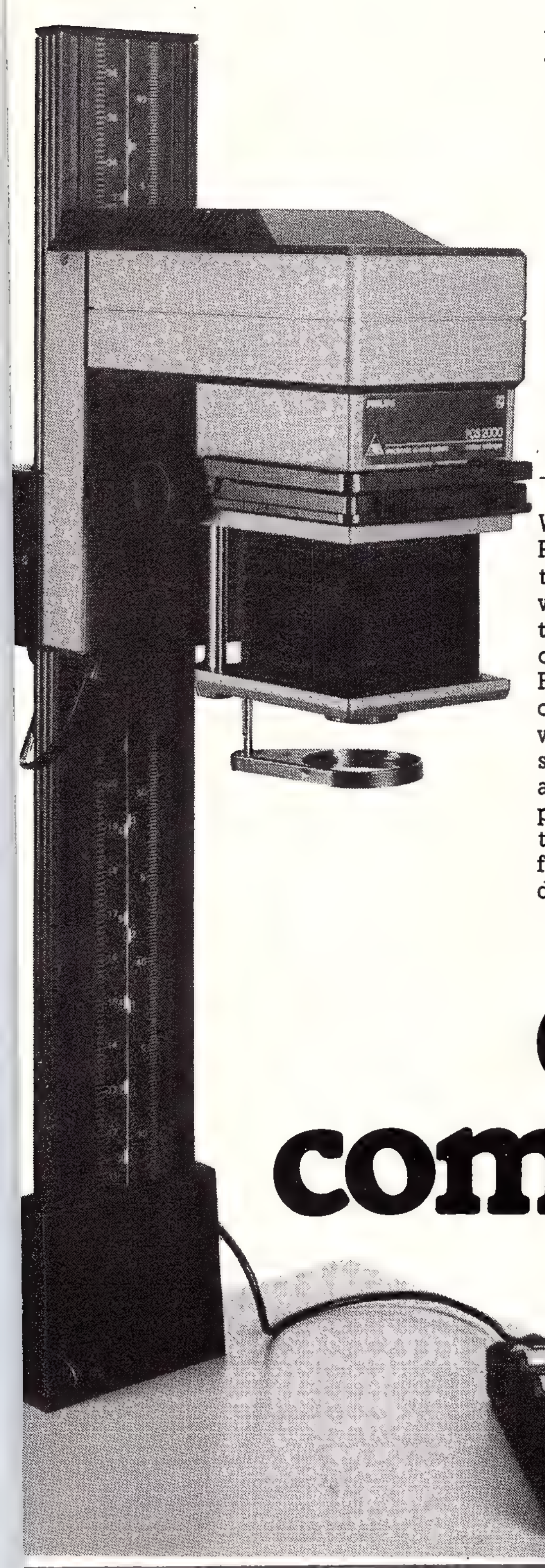


Figure 1. This is how the darkroom computer is connected to the Philips enlarger/control unit PCS 130/PCS 150, using an optocoupler.

When connecting the darkroom computer to Philips enlargers PCS 130/150 and PCS 2000, the problem is that these units are equipped with built-in timers. There is therefore a risk that the built-in timer will affect functioning of the timer in the darkroom computer. Furthermore, these enlargers have a 'power-on reset'. This means that the enlarger lamp will not light up when the mains voltage is switched on. It is therefore not possible to activate the lamp using the darkroom computer via the mains plug or mains switch of the enlarger. The object of the exercise is to find some point on these units to which the darkroom computer can be connected.



PCS 130/150

With this type, the connection can be made very simply using an optocoupler. Figure 1 contains a sketch showing the connection between the darkroom computer and a PCS 150 enlarger using an optocoupler. Relay Re1 in the darkroom computer is replaced in this case by a 150 Ω resistor and the LED of the optocoupler. The phototransistor of the optocoupler is now wired in parallel with the stand-by terminals of the Focus/Adjust/Stand-by switch in the enlarger. Shown in figure 2 is a section of the printed circuit board of the PCS 150, with connection points properly marked. The control unit of the enlarger contains sufficient space to accommodate the additional optocoupler. The LED terminals can be wired to a socket, thus allowing the connection to the darkroom computer to be made with a plug and cable.

PCS 2000

The PCS 2000 enlarger presents something more of a problem. This enlarger is equipped with an automatic lamp shutoff circuit which ensures that the bulbs are not on for more than 2.5 minutes. This provides protection against overheating. The protection is only required in the 'Adjust' and 'Focus' settings. In the 'Stand-by' setting the maximum time that can be adjusted is 40 seconds, which means that the lamp shutoff circuit does not become operational in this case. If one wishes to connect the darkroom computer to the enlarger, the connection must be made via the 'Stand-by' setting of the Focus/Adjust/Stand-by switch. In this case the connection must be made in such a way that the protection circuit also functions if an excessively long time is selected with the darkroom computer. The desired method of connection is made possible using a relay with two changeover contacts. The relay must be wired according to figure 3. If one opens the housing of the control unit and views the component side of the printed circuit board, the section illustrated in figure 4 can be seen. The relay is wired in as shown in figure 4. One of the leads of R29 is snipped off and a normally-closed relay contact is wired between the two free ends. Two stranded wires are connected to pins 23 and 25 of switch SK-5 on the solder side of the p.c.b. These two wires are also routed to the relay and connected to the second (normally-open) contact as shown in figure 4 (see also figure 3).

The relay must be rated for a coil voltage of 5 V. It should also be as small as possible to facilitate installation in the control unit. A suitable relay, quoted here as an example, is RAPA type 08E-4,5-002/7, whose wiring diagram is shown in figure 3.

The two coil terminals for the relay can be wired to a socket which is fitted to the control unit. A plug and cable are then used to connect the enlarger to the darkroom computer. If the darkroom computer is not connected, the PCS 2000 functions normally.

Operation

Once the modifications have been made, set the Focus/Adjust/Stand-by switch to the 'Stand-by' position. It is now possible to work with the darkroom computer and enlarger combination as though a normal enlarger were connected. However, care must be taken not to press the timer-start button on the control unit, otherwise the times selected with the darkroom computer will not apply. The focus function can be activated either with the corresponding key on the control unit or with that of the darkroom computer. If one does not wish to switch the darkroom lighting with the computer, Re1 can be omitted. In this case, however, some care must be taken with light measurements otherwise they can

2

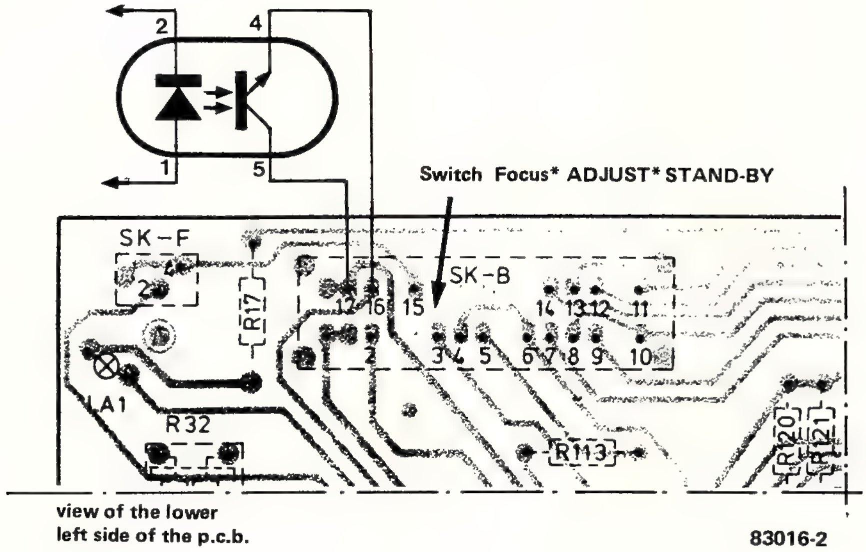

2
4
1
5
Switch Focus* ADJUST* STAND-BY
SK-F
2
R17
SK-B
12
16
15
14
13
12
11
2
3
4
5
6
7
8
9
10
LA1
R32
R113
R20
R21
view of the lower left side of the p.c.b.
83016-2

Figure 2. This is how the optocoupler is connected to the printed circuit board of the control unit. The figure shows the soldering side.

3

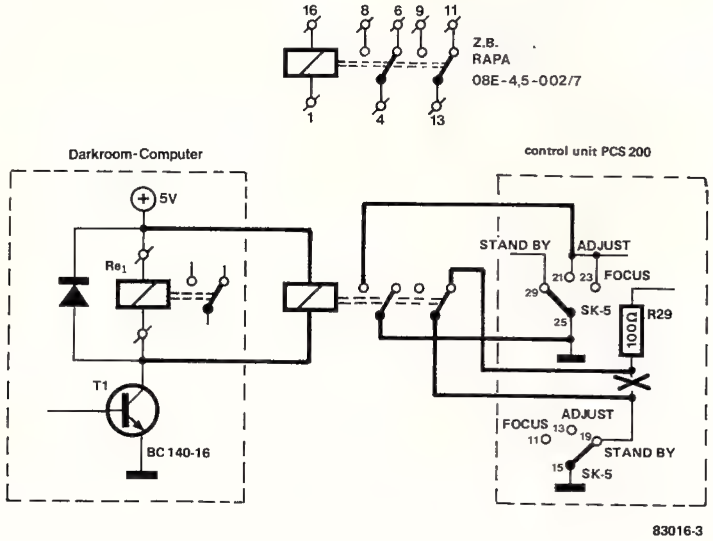


Figure 3. The PCS 2000 is connected to the darkroom computer by means of a relay with two changeover contacts.

4

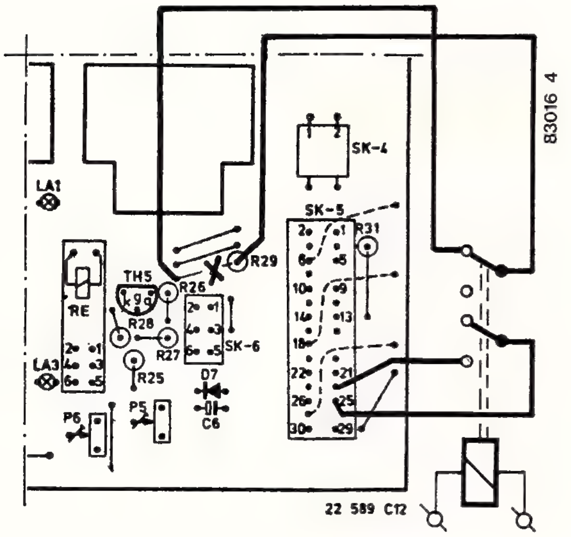


Figure 4. This is how the relay is connected to the printed circuit board of the control unit. The figure shows the component side of the board.

be influenced by the darkroom lighting. It is therefore better to use the computer for switching the darkroom lighting for light and contrast measurements.

Improving the linearity

It is possible to improve the linearity of the thermometer to some extent. T2 (BC 547B) should be replaced by a BS 170 and R10 should be reduced to 10 Ω. In this way the residual voltage over C3 is reduced from 10 . . . 15 mV to about 1.5 mV. The fairly linear response (maximum deviation +0.2°C) thus becomes even more linear.

The pin configuration of the BS 170 is the same as that of the BC 547, so that the modification can be made very simply.

Improving the second process timer

If the second process timer (which is visible on the display) is used, the fact that the first process time always reappears on the display when the timer is stopped intermediately (with the START/ST button) may be inconvenient. It would be more practical for the timer to return to the beginning of the current process time. This is made possible by a software modification which requires changing of the following addresses in the EPROM:

Address	Data	
09A8	49	(previously: C9)
09AB	08	(previously: 04)
09B3	2E	(previously: 5E)
09B5	5E	(previously: 0A)
09B7	0A	(previously: 5A)
09B9	5A	(previously: 2E)

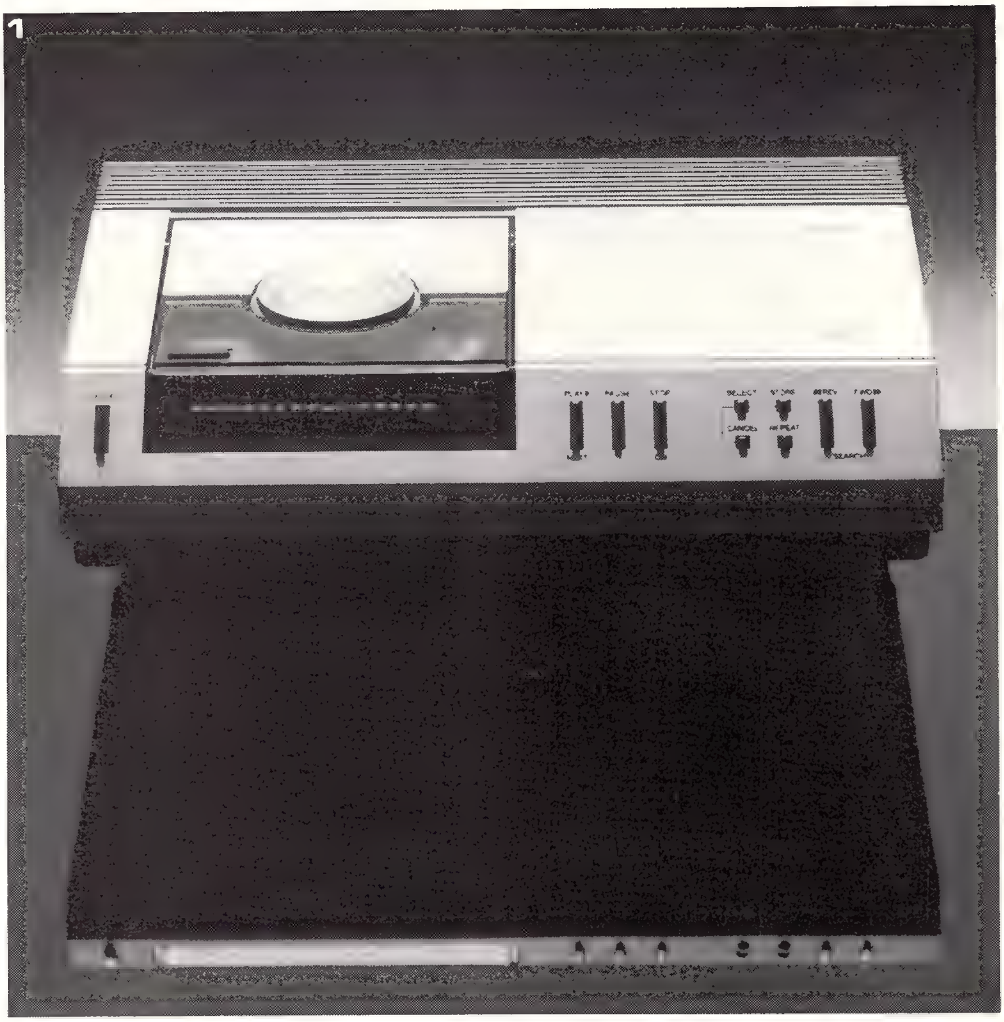
If the START/ST button is pressed whilst the timer is running it stops and the start of the current time is displayed. This is because one normally stops it when the preset time has elapsed and the buzzer is heard. If, for example, one stops the timer when the fourth time has elapsed, the start of the fifth time appears on the display. When the START/ST button is pressed again, timing continues from this point. Other controls remain unchanged.

The new program has been incorporated in the Elektor Software Service under number 514-N, thus providing the user with a choice of two different versions. ◼

So far, digital audio has only been demonstrated in studios, development laboratories, industrial fairs and exhibitions. In the hi-fi enthusiast's living room, however, the most that can be expected is a normal LP, marked appealingly if dubiously 'DIGITAL' because the master tape was recorded using digital technique. But let's face it: there is no doubt that digital audio will soon be in the living room. The chips are already available, which means that the equipment will soon be on the market.

chips for digital audio

1



Photograph 1. The Philips CD 100 is one of the first CD players on the market.

Digital audio is not an end in itself. Until it becomes marketable, the technical advantages will be relatively unimportant.
What do we mean by 'marketable?' To the semiconductor manufacturers this simply means that the technique must be suitable for applications in entertainment electronics. The marketability of digital audio is centered on one significant aspect: chips. Particularly in the field of consumer goods, it is important that the introduction of new techniques provides the equipment manufacturers with commercial advantages. For digital audio, this precondition can only be met through the use of LSI techniques. Even with the fastest microcomputers available at present, the digital processing of audio signals can just about be executed. The demands made by digital audio techniques on signal processors are extremely high, both with respect to computing speed and complexity of the operations. This is also one of the reasons for the long wait for 'digital audio'. As far as the IC manufacturers are concerned, the demands are almost at the limit of what is economically feasible.
There is no doubt, however, that this technique will soon be a vital part of entertainment electronics. Digital LSI circuits for the entire signal processing system can provide further rationalisation in production: less system components, automated component insertion, alignment and testing, as well as greater flexibility in adaptation

1

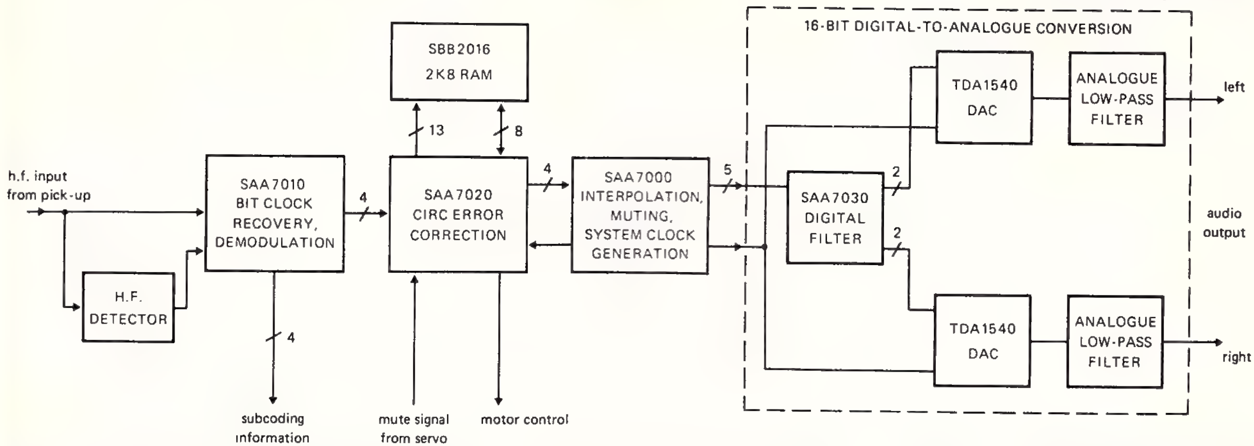


Figure 1. Block diagram of the compact disc decoder.

to the needs of the market. This last aspect is particularly fascinating. In future, model variants will require few circuit modifications, if any, and will be obtained by software changes.

The future is already here

Digital audio ICs already exist – at least from pilot production, as samples for the equipment manufacturers. As can be expected, some of these are chips which are utilised in compact disk players. Others, however, are from an unexpected field of application:
the TV set!
Clearly, a digital disk player cannot be designed without digital audio ICs. Who needs a rack full of printed circuit boards under his record player, as was the case at an international electronics exhibition in 1981? In contrast, the very compact pilot-production equipment demonstrated at many international Hi-Fi- Video Exhibitions this year was already equipped with the LSI circuits developed for mass-production (see photographs 1 and 2). The block diagram of the signal processing in the CD player (figure 1) shows that a considerable number of chips on the decoder board (signal processing) are utilised for reconstitution of the digital audio information from the signal delivered by the laser pick-up. The chips in this section were specially developed for applications in the CD player and cater for high-frequency demodulation, clock recovery, extensive error correction and speed control of the drive motor. The digital audio signal played back from the disk and error-corrected is presented at the output of this CD-dedicated signal processing circuitry. Shown within the dashed lines is a two-channel, 16-bit digital-to-analogue converter, based on three ICs. This converter is one of the first, significant functional blocks for digital audio in a marketable form. This type of module is required in every digital audio system, to obtain a reconstituted, analogue audio signal at the end of the digital signal chain. Since there are no digital power amplifiers (nor digital loudspeakers!), there is no alternative to conversion back to an analogue signal. Moreover, converters for digital-to-analogue and vice versa will still be needed for a long time, to be able to utilise digital audio components in existing, analogue hi-fi systems. One can say, therefore, that the fully digital audio system is still in the distant future.
However, digital signal processing in television sets, including the audio section, is very close at hand. This may appear strange, but it is supported by convincing economic arguments. Particularly with a colour television set and its fairly involved circuitry, the manufacturing costs can be considerably reduced through digitisation using a few LSI circuits. The advantage to the consumer is improved characteristics, such as higher reliability and a better picture and sound.

2

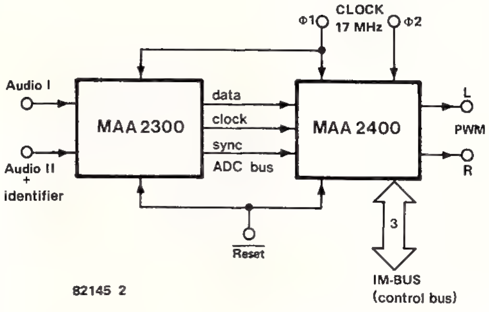


Figure 2. Block diagram of a digital preamplifier and control amplifier, consisting of a 2-channel A/D converter and an audio processor.

3

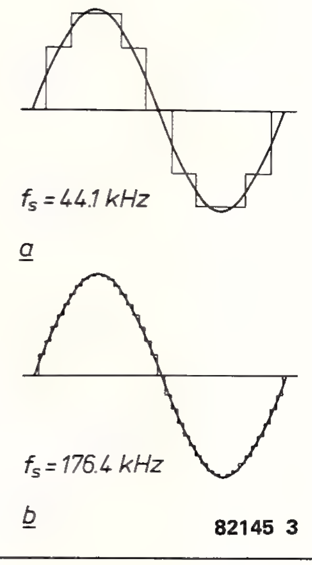
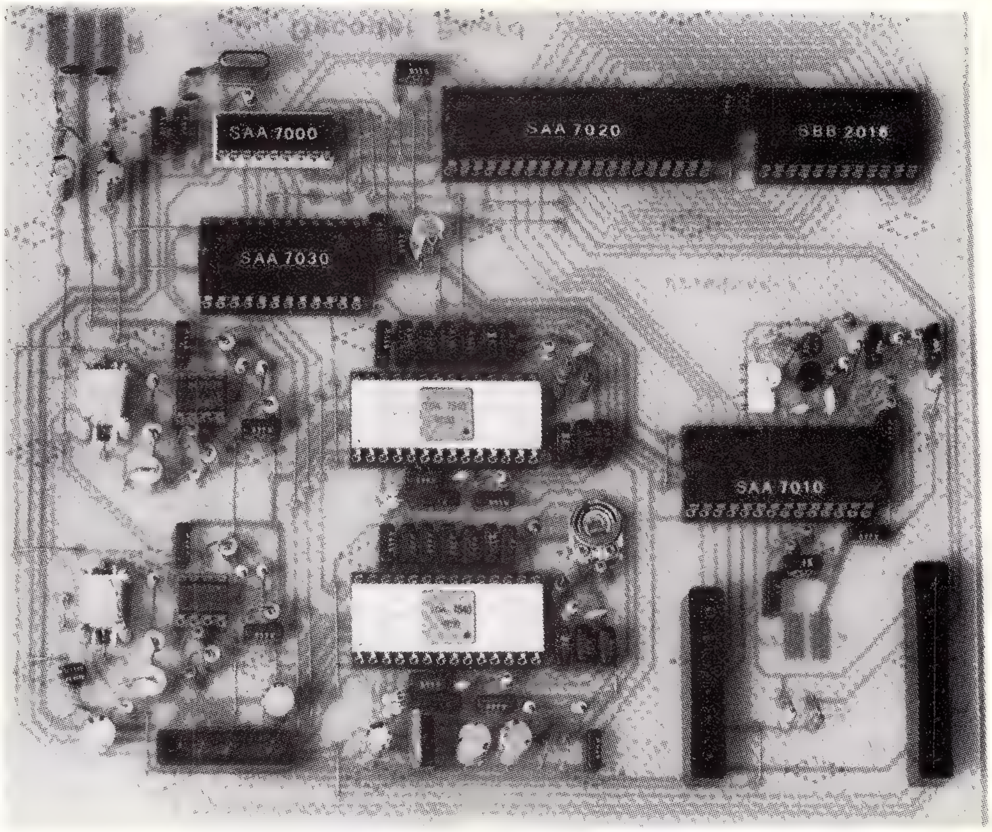


Figure 3. 4.41 kHz sinusoidal signal, sampled with 44.1 kHz in figure 3a and with four-times the frequency in figure 3b. The sampling process results in a staircase voltage which is an approximation of the original signal. The higher the sampling frequency, the closer the approximation. With the higher clock-frequency sampling rate, harmonics of the staircase signal can also be filtered out more easily.

2



Photograph 2. This is the most important p.c.b. of the digital recorder player. Four NMOS ICs perform most of the digital audio signal processing; this necessitates more than 4 million operations per second.

ITT-Intermetall have developed two interesting digital audio ICs for this 'digital TV set': an analogue-to-digital converter and a digital audio processor. Both chips are designed for processing two audio channels (stereo) and are not only suitable for stereo TV but also for purely audio applications. The signal processor can directly process digital signals from a disk player or tape unit. Figure 2 shows the block diagram of a digital, stereophonic audio-processing system using these two chips, which we shall discuss in a future article.

14-bit D/A converter with 16-bit characteristics

Within the compact disc, some important parameters were established for future digital audio equipment: a sampling frequency of 44.1 kHz and 16-bit analogue-to-digital conversion.

The choice of 16 bits per sample was a brave decision: this resolution also complies with the studio standard for digital audio, allows a signal-to-noise ratio of 96 dB (6 dB per bit) and delivers a data flow of more than 1.4 million bits per second (with two audio channels)! This has set a quality standard which will meet future requirements, but which also represents a challenge to the technology that must be provided by the IC manufacturers. In the case of the 16-bit converter for the CD player, this challenge apparently resulted in a new solution: 16 bits converted with a 14-bit converter. Since no 16-bit D/A converter was developed for the CD player, there is reason to suppose that Philips originally intended to use 14 bits for the compact disk, but was 'obliged' to adopt a 16-bit system as development progressed. At any rate, the TDA 1540 14-bit D/A converter was presented in 1980. Thanks to a clever current division method, called 'dynamic element matching' by Philips, it exhibits outstanding linearity which allows a signal-to-noise ratio of 85 dB (according to the manufacturer). Dynamic element matching is a dynamic compensation method in which the errors of individual currents are eliminated by switching and mean value formation. This therefore dispenses with the very expensive laser trimming of the summing resistors with conventional D/A converters. In addition to the high linearity which corresponds to that of a 15-bit converter, the TDA 1540 also exhibits a very fast operating speed. It processes a maximum of 12 million bits per second, allowing its application in systems with sampling frequencies of up to 850 kHz, which corresponds to signal bandwidths of more than 400 kHz. This is certainly more than sufficient for digital audio!

Oversampling: greater bandwidth results in reduced noise

But let us get back to the 16-bit converter. Why develop a 16-bit D/A converter when an excellent 14-bit D/A device already exists? Maybe this was the train of thought at Philips. The fast operating speed of the TDA 1540 makes it possible to increase the signal-to-noise ratio above the 85 dB of the 14-bit converter, using a method known as 'oversampling'. There is nothing particularly spectacular about oversampling; on the contrary, it is a relatively simple process. According to Nyquist's sampling theorem, the sampling frequency must be at least twice as high as the highest signal frequency. For reasons of bit economy (why produce more bits than absolutely necessary according to Nyquist?), the sampling frequency chosen is not much higher in practice. If it is higher, however, the process is referred to as 'oversampling'. Oversampling does not only provide more bits, but also advantages. The transmission bandwidth becomes greater than the signal bandwidth. The quantisation noise is therefore distributed over a greater bandwidth and becomes correspondingly less within the signal bandwidth. In this case of the 16-bit converter in the CD player, oversampling with a factor of four is employed; the sampling frequency is increased from 44.1 kHz to 176.4 kHz. The quantisation noise is distributed over a bandwidth which is four times greater; the residual noise within the audio bandwidth is only one quarter of the original figure. Expressed in decibels, the gain in the signal-to-noise ratio is 6 dB. This brings the original 85 dB of the TDA 1540 up to 91 dB, which corresponds to the figure for a good 15-bit converter.

Oversampling provides yet another advantage. Figure 3 shows a sinewave of 4.41 kHz, sampled with 44.1 kHz in figure 3a and with four-times the frequency in figure 3b. The sampling results in a staircase approximation of the signal curve. At the higher sampling frequency this approximation is considerably closer, so that the 'staircase voltage' harmonics presented by the signal after D/A conversion can be filtered out much more simply.

This point is highly significant. Figure 4c shows the spectrum of an audio signal with a bandwidth of 20 kHz, sampled with 44.1 kHz. Theoretically, an infinite number of harmonics are produced which consist of integral multiples of the sampling frequency, with sidebands which are 20 kHz wide in each case. Of course, this wide and unfiltered spectrum must not be applied to the audio amplifier and loudspeakers. Although the frequencies above 20 kHz are beyond the audible range, they would cause amplifier blocking and would produce audible intermodulation products. For this reason, a digital audio system should attenuate all frequencies above 20 kHz by at least 50 dB at its analogue output. This task is normally performed by steep-sloped filters after the D/A converter; however, they are not a healthy business proposition because of the large number of components required and subsequent alignment. Furthermore, such steep-sloped filters do not exhibit a linear phase response in the pass band, thus resulting in impaired reproduction of pulse-type sound, according to the audio experts.

The heart of the module: SAA 7030 digital filter

In the 16-bit D/A converter of the CD player, this problem is solved with a digital module which also caters for the over-

4

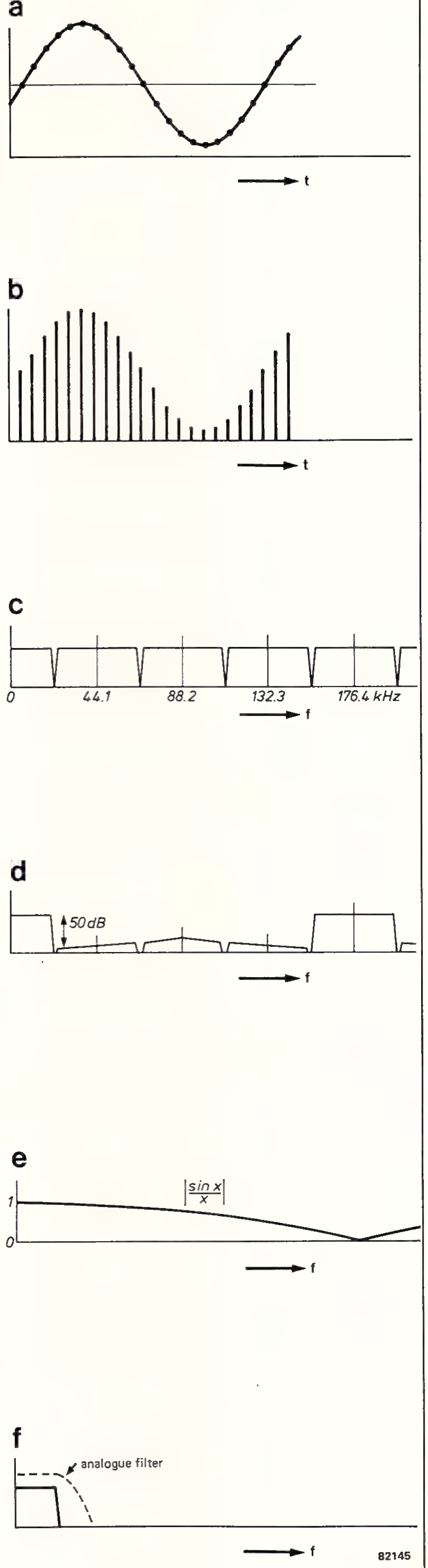


Figure 4. The digital audio signal and its spectral breakdown:

a. The original analogue signal

b. The sampling process results in a train of pulses whose amplitude corresponds to the instantaneous value of the analogue signal (pulse amplitude modulation).

c. Frequency spectrum of such a pulse train. The sampling frequency is 44.1 kHz; the sampled signal (analogue signal) is within the audio range of 0-20 kHz.

d. Spectrum after oversampling with 176.4 kHz and digital filtering. This makes it considerable easier to filter out the frequencies above the audio range (about 20 kHz), because the sidebands with 44.1, 88.2 and 13.2 kHz are already attenuated.

e. The hold function of the digital-to-analogue converter results in further filtering with the sin x/x curve depicted; the first null point of this function is at 176.4 kHz.

f. The rest ist handled by a simple analogue low-pass filter with a cutoff frequency between 30 and 40 kHz at the output of the D/A converter.

5

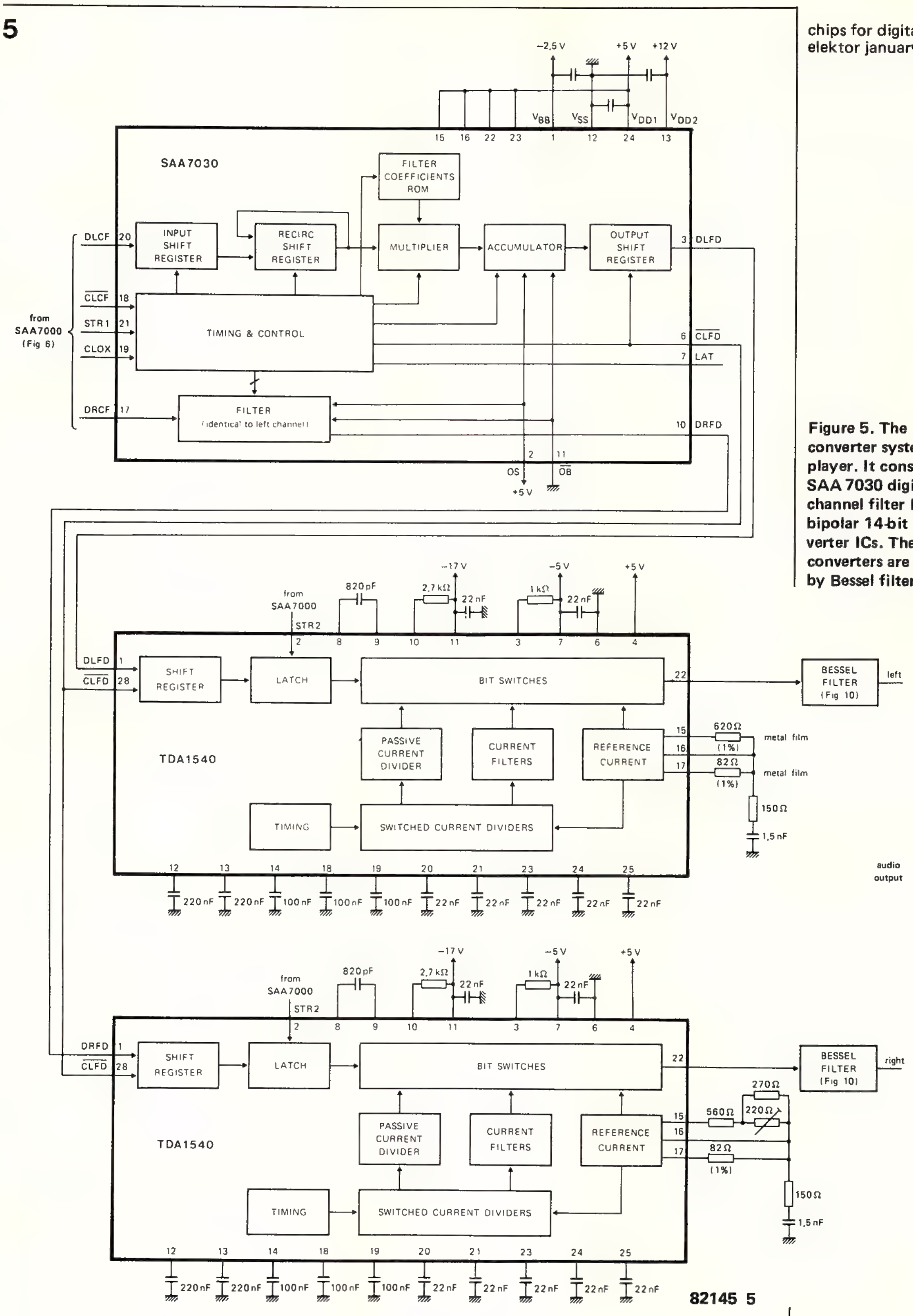


Figure 5. The 16-bit D/A converter system in the CD player. It consists of an SAA 7030 digital two-channel filter IC and two bipolar 14-bit D/A converter ICs. The D/A converters are followed by Bessel filters (figure 8).

sampling and 'rounding off' from 16 to 14 bits for the two TDA 1540s. Figure 5 shows the full circuit of the stereo D/A converter, based on the three ICs. The heart of the module is the SAA 7030 digital oversampling filter IC in NMOS technology. It processes both stereo channels. After demodulation and error-correction in the previous stages, the music is applied in 16-bit serial form to inputs DLCF and DRCF of the SAA 7030. First it places them in shift registers which quadruple the sampling frequency from 44.1 kHz to 176.4 kHz. This also effectively increases the audio bandwidth from 22 to 88 kHz, reducing the quantisation noise within the 22 kHz bandwidth by 6 dB. The three intermediate values required on account of oversampling by a factor of four (a quadrupled sampling frequency means four samples instead of one in the same

6

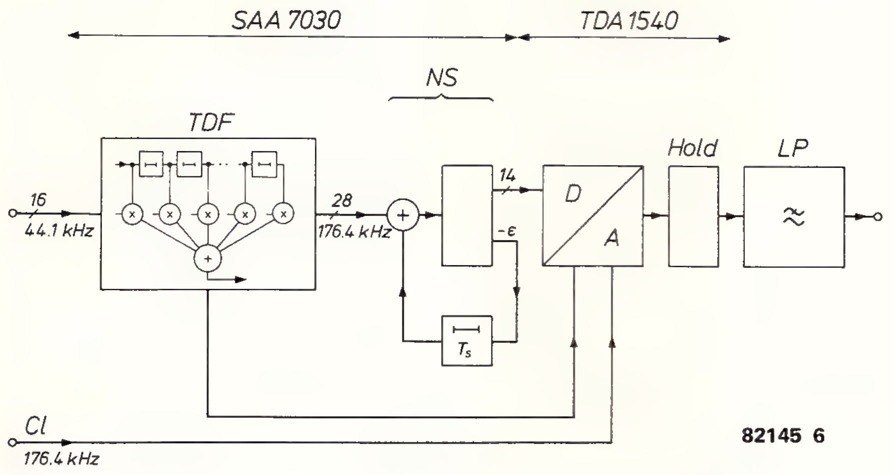
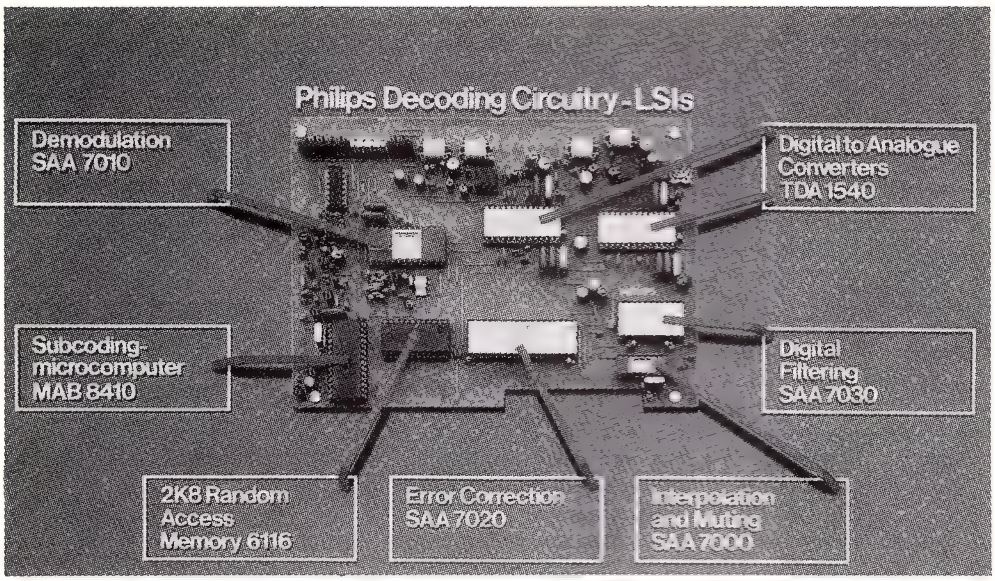


Figure 6. Block diagram of the D/A system in figure 5. The transversal digital filter (TDF) increases the sampling rate from 44.1 to 176.4 kHz and attenuates the harmonics in the spectrum of the sampling signal (see figure 4). The noise shaper (marked NS) rounds off the 28-bit signal from the filter output to 14 bits and feeds the rounding error back to its output, delayed by one sampling period Ts and with changed sign, where it is added to the next sample.


Philips Decoding Circuitry - LSIs
Demodulation SAA 7010
Digital to Analogue Converters TDA 1540
Subcoding-microcomputer MAB 8410
Digital Filtering SAA 7030
2K8 Random Access Memory 6116
Error Correction SAA 7020
Interpolation and Muting SAA 7000

7

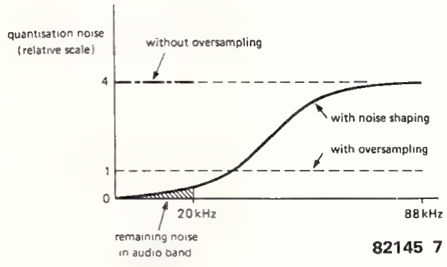


Figure 7. A signal-to-noise ratio corresponding to that of a 16-bit D/A converter is obtained using 14-bit D/A converters, by reducing the quantisation noise: oversampling (with four-times the sampling frequency) brings the signal-to-noise ratio of the 14-bit D/A converters from 84 to 90 dB; the noise shaper reduces the noise in the audio band of up to 20 kHz by a further 7 dB, thus resulting in a total signal-to-noise ratio of 97 dB which corresponds to that of 16-bit systems.

unit of time), are generated by the filter by way of multiplication of the input data by the filter coefficients and summation. Since the coefficients are numbers with a length of 12 bits, products with a length of 28 bits are produced in the accumulator after the filtering operation; these products now represent the samples (sampling frequency 176.4 kHz). From these 28-bit words, only the 14 most significant bits (the 'upper' ones) are shifted to output DLFD for the left channel and DRFD for the right channel. The remaining bits (14 least significant bits) are not discarded; their sign is changed and they are added to the next sample arriving in the accumulator. This feedback of the rounding error results in a reduction of the quantisation error created by the transition from 16 to 14 bits for slowly varying signals, i.e. low frequencies. A lower quantisation error at low signal frequencies signifies lower quantisation noise in the lower region of the frequency range. This can also be seen in the spectrum of the quantisation noise: lower at low frequencies and higher at high frequencies. This feedback of the rounding error, known as 'noise shaper' by Philips, provides another 7 dB reduction in noise over the audio range from 0 to 20 kHz. Together with the 6 dB obtained by oversampling, this is a dynamic gain of no less than 13 dB. Taking a figure of 84 dB for the TDA 1540 14-bit converter (without oversampling and noise shaping), the entire system consisting of the SAA 7030 plus TDA 1540 exhibits

8

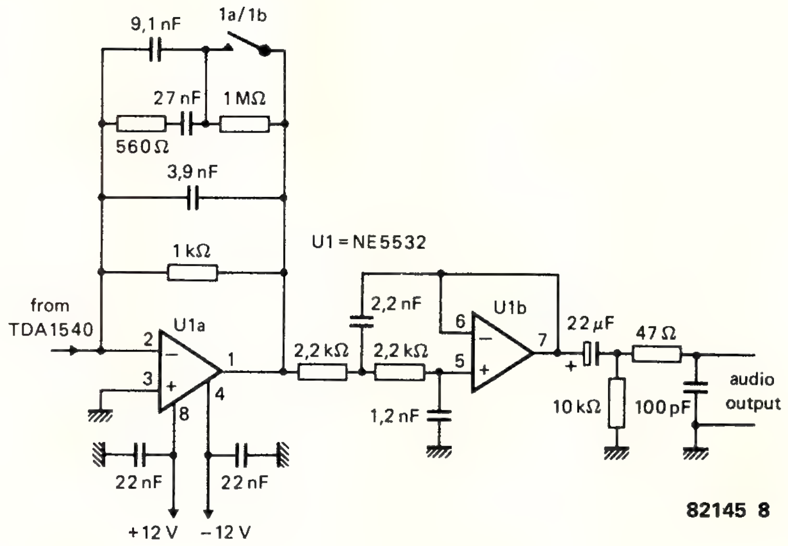


Figure 8. Third order Bessel lowpass filter at the output of the TDA 1540 D/A converter. Switch 1a/1b switches a de-emphasis network into the circuit if required.

a maximum signal-to-noise ratio of 97 dB, which corresponds to that of a 16-bit D/A converter. It is therefore quite justifiable to describe the system as having a 16-bit converter, although the D/A circuit itself is only a 14-bit device.

The actual task of the digital filter is to remove interfering harmonics from the spectrum of the PCM signal. The filter coefficients are selected so that the filter suppresses harmonics between the audio range and the two sidebands of the 176.4 kHz oversampling frequency. This residual spectrum around the oversampling frequency is attenuated by the hold function of the TDA 1540. The TDA converter does not present needle pulses at its output, whose amplitude corresponds to the sample value, but holds each sample until the next sample arrives. Thus the staircase voltage shown in figure 3 is produced, instead of a train of needle pulses. With regard to the effect on the spectrum of the signal, it is as though the spectrum of the PCM signal (figure 4) would be filtered with a filter with the sin x/x response in figure 4. This curve has a (first) null point at 176.4 kHz.

Prefiltering with the SAA 7030 digital filter and the hold function of the TDA 1540 allows the use of a simple third-order analogue filter to attenuate the remaining high-frequency interfering signals. In order to obtain a linear phase response, a Bessel lowpass filter with a cutoff frequency of 30 kHz and rolloff of 18 dB/octave is utilised. As shown in figure 8, the current output of the TDA 1540 D/A converter is connected to the virtual ground point at the inverting input of the first operational amplifier in the filter, so that the output filters also cater for conversion of the output current of the D/A converters to an output voltage. All the usual hi-fi equipment can be connected to the analogue audio output; the level corresponds to that of the line level of the auxiliary inputs of amplifiers.

Not only for the compact disc

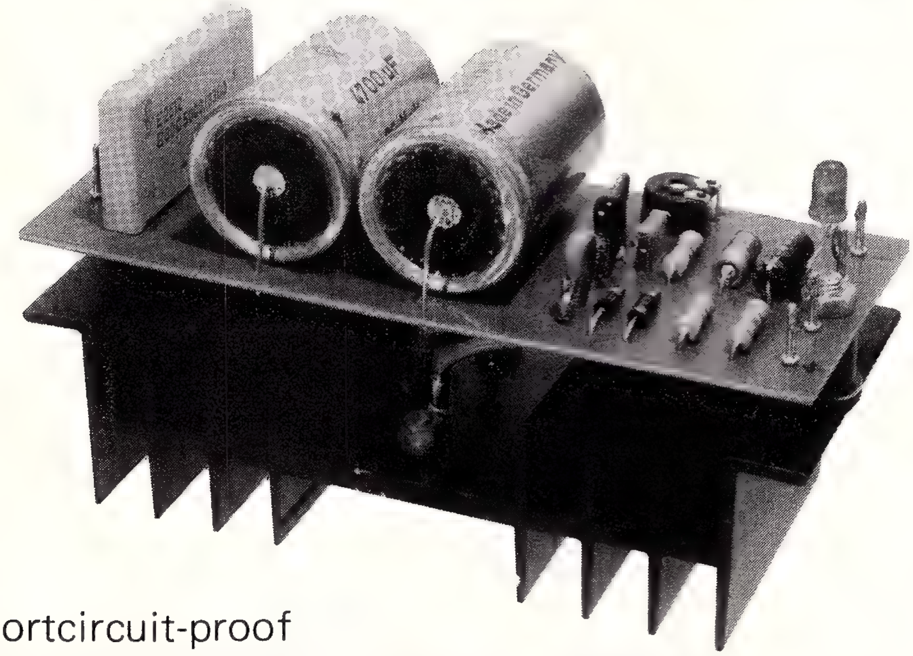
This concept makes available for the first time a low-cost converter of professional 16-bit quality, based on ICs that can be mass-produced. For applications other than the compact disc, this D/A converter can also be operated with other sampling frequencies. The cutoff frequency of the digital filter remains at 0.45-times the sampling frequency and the sin x/x curve of the A/D hold function follows with its null point the sampling frequency. It may be necessary to redimension the analogue output filter only, in order to maintain the linear phase response in the passband. ◀

Literature:

J. Matull: 'ICs for Compact Disc Decoders', Electronic Components and Applications, Vol. 4, No. 3, May 1982, pp. 131-141.
R.J. van de Plassche: 'Monolithic 14-bit DAC with 85 dB S/N ratio', Electronic Components and Applications, Vol. 2, No. 4, August 1980, pp. 234-241.
D. Goedhart, R.J. van de Plassche and E.F. Stikvoort: 'Digital-to-analog conversion in playing a Compact Disc', Philips Technical Review, Vol. 40, No. 6, 1982, pp. 174-179.
B.A. Blesser: 'Digitization of audio: a comprehensive examination of theory, implementation and current practice', JAES (Journal of the Audio Engineering Society), Vol. 26, Nr. 10, October 1978, pp. 739-771.

If one wishes to expand a fully built personal computer, the internal power supply is usually inadequate to power additional circuitry. The relatively new generation of memory chips (RAMs, EPROMs) only need a single operating voltage of 5 V. This 5 V/3 A power supply is therefore ideal for powering additional memories, peripheral devices and the like. The power supply can be built very simply using an LM 350 voltage regulator IC. Internal protective circuits against excessive load currents and temperature rise ensure that the power supply can survive considerable mistreatment.

3 A computer power supply



shortcircuit-proof and protected against thermal overloads

Technical data

- Output voltage:
  4.7 . . . 5.7 V
  (adjustable)
- Output current:
  3 A max.
- Ripple:
  $< 1\ mV_{rms}$
- Protected against shortcircuit and thermal overload

The LM 350 voltage regulator used in this power supply has a particularly appealing characteristic: the 'common' terminal behaves as a real adjustment terminal. In contrast to the usual 3-terminal voltage regulators, the current flowing via this terminal is very low and almost independant of input voltage and load (I_{adj}). It is therefore possible to vary the output voltage by means of a simple voltage divider, without impairing the regulating characteristics.

Figure 1 shows the block diagram of such a configuration using a voltage divider. The voltage regulator develops a very stable reference voltage of 1.25 V between pins 3 and 1. This voltage produces a constant current through resistor R1 and, together with I_{adj}, a voltage is developed over R2. Thus the output voltage U_{out} is given by:

$$U_{out} = U_{ref} + (I_{adj} + U_{ref}/R1)R2$$
$$= U_{ref}(1 + R2/R1) + I_{adj}\,R2$$

1

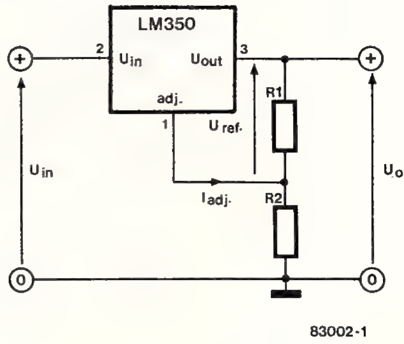


Figure 1. In contrast to the usual three-terminal types of voltage regulator, the LM 350 provides the advantage that the current I_{adj} is very low and almost independent of the input voltage and load. It is therefore possible to vary the output voltage by means of a simple voltage divider, without impairing the regulating characteristics.

As already mentioned, the (error) current I_{adj} is very low and almost independant of input voltage and load. One can therefore consider the output voltage as only being dependant on the very stable internal

2

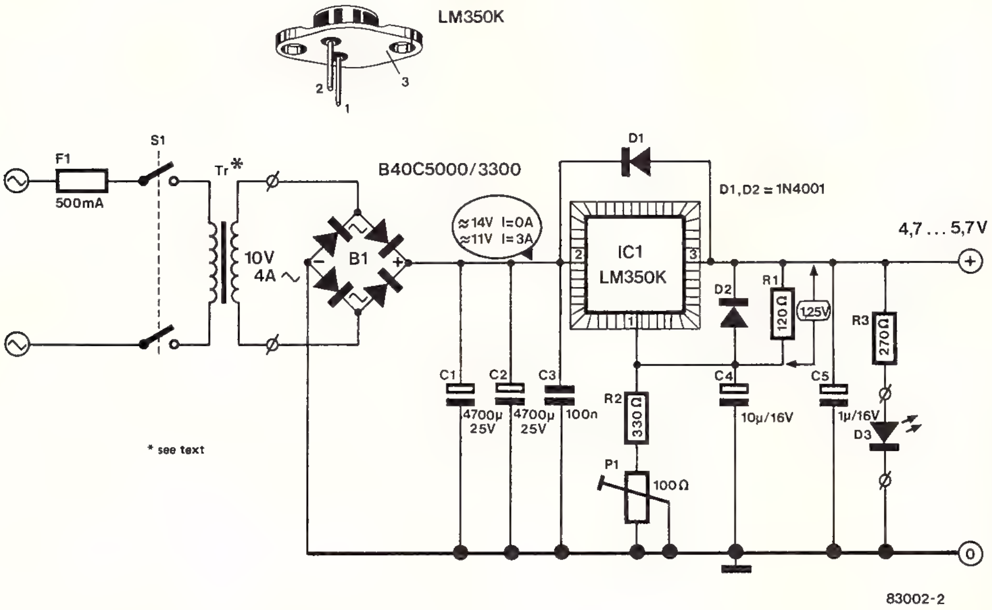


Figure 2. Thanks to the LM 350 voltage regulator, the 3 A power supply is shortcircuit-proof and protected against thermal overloads. Diodes D1 and D2 protect the regulator from voltages with inverted polarity, which could be produced by discharging capacitors.

reference voltage and the ratio between resistors R1 and R2. The value I_{adj} R2 can be discounted. The output voltage can therefore be adjusted as desired and can be made continuously variable by using a potentiometer instead of R2. In this 3A power supply a trimmer was utilized instead of R2 (P1 in figure 2). The output voltage can be set between 4.7 and 5.7 V by means of the trimmer. This arrangement allows the voltage drop over the leads to the computer to be compensated for.

The LM 350 voltage regulator is shortcircuit-proof and contains an internal protective circuit against thermal overload. The internal protection is rated to allow the regulator to deliver a current of at least 3A (shortcircuit current typically 4.5 A, depending on the device). However, the protective circuit against thermal overload does not render a heatsink superfluous: without a heatsink it would respond much too fast.

Bypass capacitors (C3 and C5) are wired at the input and output of the regulator. These capacitors also suppress any tendency of the circuit to oscillate. Capacitor C4 bypasses the regulating input (pin 1), allowing improved suppression of ripple at pin 2 to be achieved. Diodes D1 and D2 ensure that a voltage with inverted polarity is not applied to the regulator, and that the capacitors discharge through the device. If the output is shorted, diode D2 prevents capacitor C4 from discharging via pins 1 and 2 of the IC. Otherwise the latter would be distroyed before the onset of the protection circuit. Diode D1 prevents the potential at pin 3 from becoming higher than that at pin 2. This can occur, for example, when a hefty smoothing capacitor in a connected item of equipment retains a voltage for a longer period than capacitors C1 and C2, after the equipment has been switched off.

Component arrangement

The printed circuit board illustrated in figure 3 is of the same dimensions as a 50 mm-long SK03 heatsink (2.7°C/W). This facilitates construction of the power supply. The heatsink can be mounted externally at the rear of a housing, with the printed circuit board mounted internally; the same mounting holes are then used. In this case the soldering side of the printed circuit board faces the heatsink. The connecting leads to the regulator can be passed through the holes provided on it. Stranded wire with a cross-section of at least 1.5 mm^2 should be utilized for the leads to pins 2 and 3 of IC1. In any case, they must be capable of passing 3 A. Insulating mica washers and thermal paste must be used when assembling IC1 to the heatsink. The regulator must not make any electrical contact with the heatsink and/or the housing. Check this with an ohmmeter! If the power supply is to deliver a continuous current of more than 2.5 A, the bridge rectifier should also be fitted with a heatsink (bracket).

The mains transformer must be capable of supplying a current of 4 A at 10 V. Once the power supply has been built and checked for faults, the mains voltage can be switched on. The no-load output voltage is adjusted to its minimum value (4.7 V) with P1. Then connect the power supply to the computer. Switch on the power supply and the computer, and adjust P1 so that the voltage *in* the computer is exactly 5V. This allows the voltage drop over the leads to be easily compensated for. It is not advisable to set the no-load voltage to more than 5.5 V; as this is the maximum permissible voltage for TTL and microprocessor ICs. If a circuit which draws a high current should fail for some reason, the voltage drop over the leads will be reduced and the voltage then present on the leads may be too high for the electronic components. Should the no-load operating voltage required be higher than 5.5 V, thicker or (if possible) shorter leads have to be used and the power supply must obviously be readjusted.

3

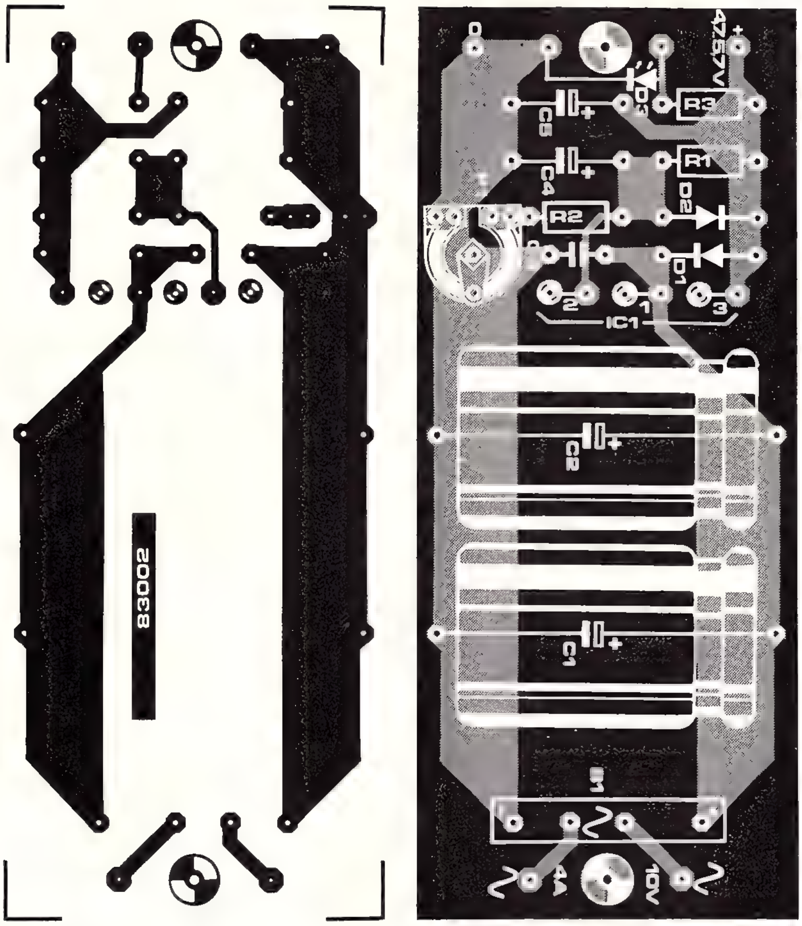


Figure 3. The dimensions chosen for the printed circuit board are such that it can be assembled into one unit together with a 50 mm-long SK03 heatsink. The connecting leads for the regulator can be passed through the holes provided on the printed circuit board.

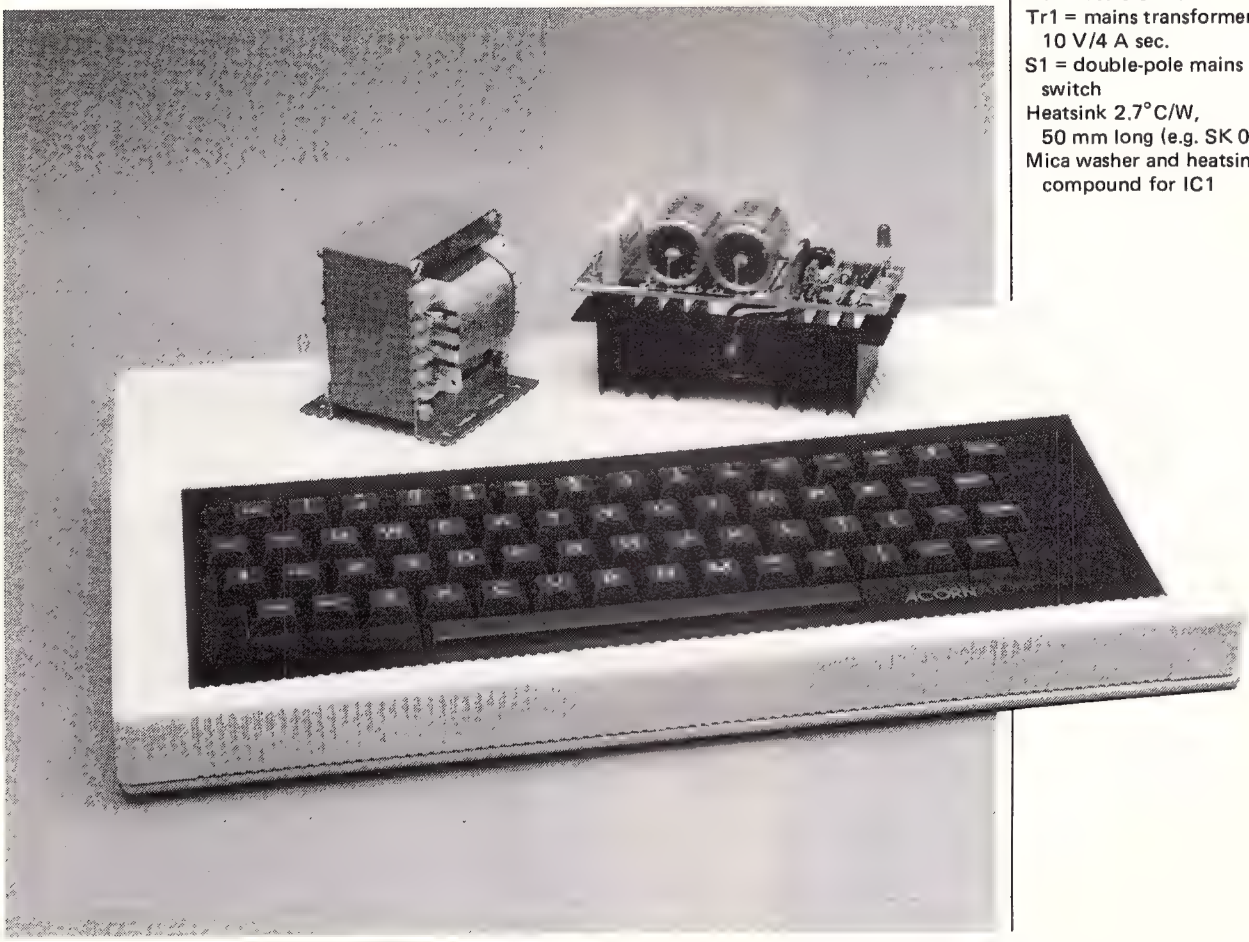
Parts list

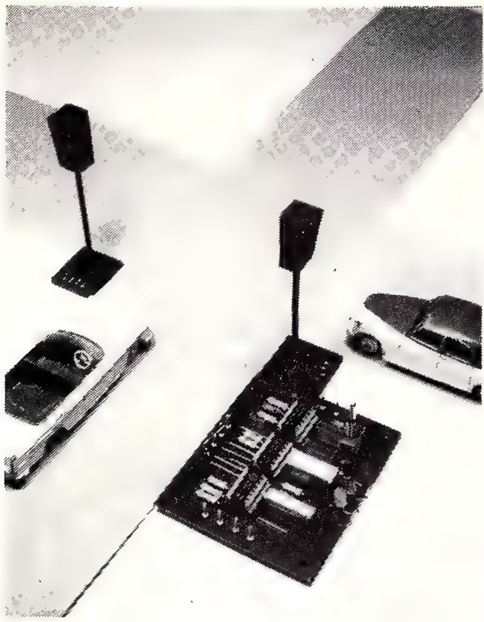
Resistors:
R1 = 120 Ω
R2 = 330 Ω
R3 = 270 Ω
P1 = 100-Ω-trimmer

Capacitors:
C1,C2 = 4700 μ/25 V
C3 = 100 n
C4 = 10 μ/16 V
C5 = 1 μ/16 V

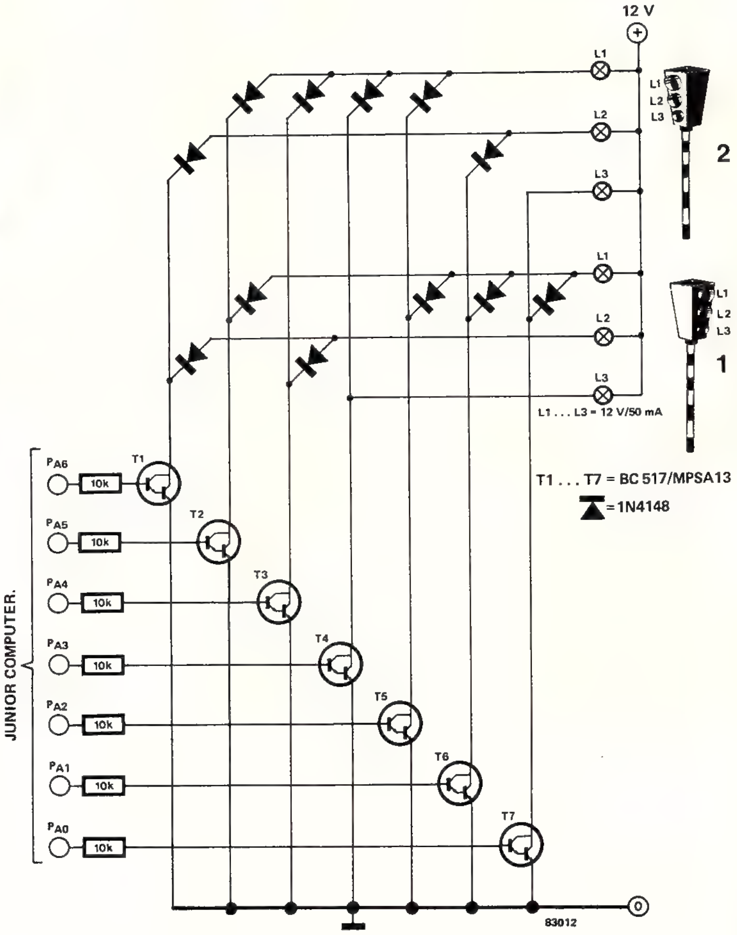
Semiconductors:
B1 = B40C5000/3300
D1,D2 = 1N4001
D3 = LED
IC1 = LM 350K TO-3 case (National Semiconductor)

Miscellaneous:
F1 = fuse 0.5 A slow
Tr1 = mains transformer 10 V/4 A sec.
S1 = double-pole mains switch
Heatsink 2.7°C/W, 50 mm long (e.g. SK 03)
Mica washer and heatsink compound for IC1





This classical task for a microcomputer, a control function which can otherwise only be implemented with a considerable amount of hardware, is executed by a program. Computers have been employed for fullscale versions of this technique for some time. This is now an opportunity to utilise the Junior Computer for the same application in miniature.



D. Herzberg

traffic-light control system...

. . . with the Junior Computer

The hardware can be easily constructed on a small perforated board, which can be positioned in the vicinity of the port connector. The two traffic lights are connected via two three-core control lines. The positive operating voltage can be taken from smoothing capacitor C5 of the basic power supply for the Junior Computer. Any other unregulated 12 V power supply is just as suitable. Bulbs with different voltage ratings will of course require a different operating voltage. Constructors who prefer to use LEDs for the traffic lights must join the anodes of the LEDs and connect them to the positive operating voltage via a (common) limiting resistor. At 12 V and an LED current of 60 mA (10 mA per LED), for example, the value of the resistor is 200 Ω/1 W. If all LEDs light up equally brightly, a limiting resistor of 1k2, 1/2 W must be connected in series with each LED.

As in the case of other circuits requiring a minimum amount of hardware, this article will merely provide some details regarding construction. Figure 1 shows the control stages for a total of six bulbs in two traffic lights, together with leads and a diode matrix which also provides a protective function. The two traffic lights are controlled by the program in table 1.
The program can best be described on the basis of the Assembler listing in table 1. Starting at address 0200, the computer starts to 'shift' a logic 1 (which corresponds to a logic 0 at the collectors of the Darlington driver transistors) from PA1 via PA5 to PA0. The traffic light cycles are: traffic light 1 – red, traffic light 2 – amber (for 2 s); TL1 – red/amber, TL2 – red; TL1 – green, TL2 – red (for 10 s); TL1 – amber, TL2 – red; TL1 – red, TL2 – red/amber (for 2 s); TL1 – red, TL2 – green (for 10 s). The cycle then starts

```
                JUNIOR'S ASSEMBLER              PAGE 01
0010: 0200                      ORG   $0200
0020:
0030:
0040:                     TRAFFIC LIGHT SIMULATION WITH THE JUNIOR COMPUTER
0050:
0060:
0070:                     WRITTEN BY DIETER HERZBERG BERLIN
0080:
0090:                     DEFINITION OF ADDRESSES
0100:
0110: 0200                PA     *     $1A80  PORT A DATA REGISTER
0120: 0200                PADD   *     $1A81  PORT A DATA DIRECTION
0130:
0140: 0200                TIMERD *     $1A97
0150: 0200                END    *     $1A85
0160:
0170:
0180: 0200 A9 7F    START  LDAIM $7F    INITIALIZE PORT A
0190: 0202 8D 81 1A        STA   PADD
0200:
0210: 0205 A0 02    LOOP   LDYIM $02    LOOP COUNTER
0220: 0207 8C 80 1A        STY   PA     BEGIN WITH PHASE 1 =A1:RED/A2:AMBER
0230:
0240: 020A 20 2F 02 NEXT   JSR   SHORT  WAIT FOR 2 SECONDS(PHASE 1+2)
0250: 020D 0E 80 1A        ASL   PA     PHASE 2+3
0260: 0210 88              DEY
0270: 0211 D0 F7           BNE   NEXT
0280: 0213 20 2C 02        JSR   LONG   WAIT FOR 10 SEC.AT PHASE 3
0290: 0216 A0 02           LDYIM $02    PHASE 4+5
0300:
0310: 0218 0E 80 1A NEXTA  ASL   PA
0320: 021B 20 2F 02        JSR   SHORT  WAIT FOR 2 SEC. (PHASE 4+5)
0330: 021E 88              DEY
0340: 021F D0 F7           BNE   NEXTA
0350: 0221 A9 01           LDAIM $01    PHASE 6=PHASE 1
0360: 0223 8D 80 1A        STA   PA
0370: 0226 20 2C 02        JSR   LONG   WAIT FOR 10 SEC. AT PHASE 1
0380: 0229 4C 05 02        JMP   LOOP
0390:
0400:
0410: 022C A2 28    LONG   LDXIM $28    DELAY FOR 10 SEC.
0420: 022E 2C              =     $2C
0430:
0440: 022F A2 08    SHORT  LDXIM $08    DELAY FOR 2 SEC.
0450:
0460: 0231 A9 F4    LOAD   LDAIM $F4    250 MS
0470: 0233 8D 97 1A        STA   TIMERD DIVISION FACTOR 1024 MS
0480:
0490: 0236 2C 85 1A TIMEND BIT   END    TIME OUT?
0500: 0239 10 FB           BPL   TIMEND NO
0510: 023B CA              DEX          YES LOAD TIMER WITH 2ND DELAY
0520: 023C 10 F3           BPL   LOAD   2ND TIME OUT?
0530: 023E 60              RTS
0540:
0550:
0560: 023F A9 7F    US     LDAIM $7F    ONLY IF LIGHTS ARE OUT OF ORDER
0570: 0241 8D 81 1A        STA   PADD
0580: 0244 A9 40           LDAIM $40
0590:
0600: 0246 8D 80 1A PORT   STA   PA     BOTH AMBER LIGHTS FLASHING
0610: 0249 A2 04           LDXIM $04    1 SEC. ON/OFF
0620: 024B 20 31 02        JSR   LOAD
0630: 024E AD 80 1A        LDA   PA
0640: 0251 49 40           EORIM $40    INVERT PORT
0650: 0253 4C 46 02        JMP   PORT
0660:


SYMBOL TABLE 3000 3054
END     1A85     LOAD    0231     LONG    022C     LOOP    0205
NEXT    020A     NEXTA   0218     PA      1A80     PADD    1A81
PORT    0246     SHORT   022F     START   0200     TIMEND  0236
TIMERD  1A97     US      023F


JUNIOR

M
HEXDUMP: 200,255
       0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
0200: A9 7F 8D 81 1A A0 02 8C 80 1A 20 2F 02 0E 80 1A
0210: 88 D0 F7 20 2C 02 A0 02 0E 80 1A 20 2F 02 88 D0
0220: F7 A9 01 8D 80 1A 20 2C 02 4C 05 02 A2 28 2C A2
0230: 08 A9 F4 8D 97 1A 2C 85 1A 10 FB CA 10 F3 60 A9
0240: 7F 8D 81 1A A9 40 8D 80 1A A2 04 20 31 02 AD 80
0250: 1A 49 40 4C 46 02

JUNIOR
```

again from the beginning. Another traffic light cycle is simulated with start address 023F. In this case the two amber bulbs flash at a 1 s rate. PA6 is utilized for this. The hex dump listing shows a summary of the data to be entered.

In the event of a computer fault, the diodes ensure that at least one traffic light is at red, thus preventing a traffic jam. Accidents are also almost ruled out. ◼

Beware of colour-code errors!

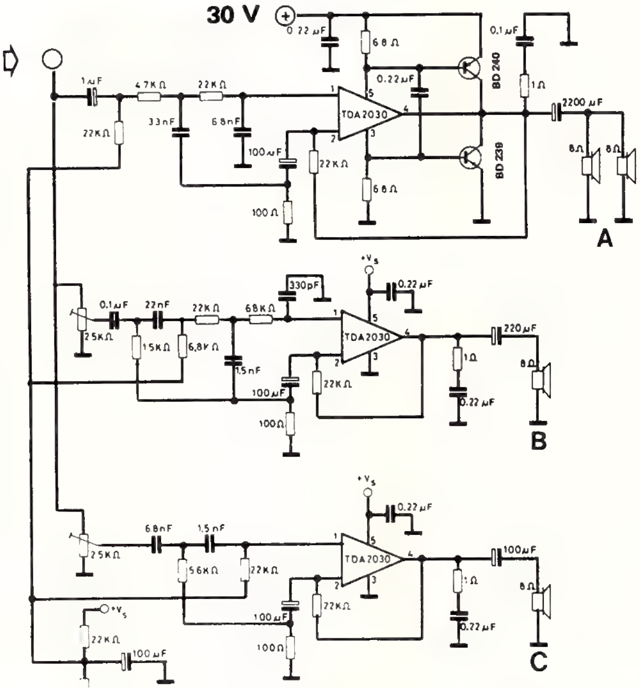
In the circuits sent in by readers, we have frequently noticed a tricky colour-code error involving resistors: sometimes it is very difficult to distinguish between 'red' and 'orange' in the resistor colour-coding.
The result is that a 10 k resistor is used instead of 1 k and, of course, the circuit does not work. Confusion is also possible with other colours.
The interpreting of colour-coding requires some care and the value should be measured in the event of doubt. It is a shame when a circuit fails to operate, simply because of an incorrect resistor.

Omission in the darkroom thermostat article

Things which seem obvious to the person written an article are sometimes not mentioned, even if they are not so obvious to the reader. This was the case with the darkroom thermostat (Elektor February 1982). A reader informs us that this circuit functions electronically, but that we failed to mention that both the hot wire and the temperature sensor must be insulated to protect them against the corrosive developing solution and to prevent electrolysis.
Here is another tip from this reader's letter: to improve the thermal distribution, position 2 x 2 m lengths of resistance wire of 10 ohms each in parallel with each other in the dish. The thinner 10 ohm resistance wire can be melted into the base of the plastic dish and given a thin insulating seal with two-component adhesive. The thermal distribution remains sufficient.

Disappearing decimal points

Infocard 53 in Elektor of June 1982 showed the circuit of an active box using a TDA 2030 under 'Applications 5'. This was an interesting circuit but was printed too small, to save space; the result was that the decimal points in some component values could only be guessed. In order to avoid problems that some readers may have in building this circuit, we are printing this circuit diagram here once again but somewhat larger.



Application 5

82184

Hot ICs — no need for fear

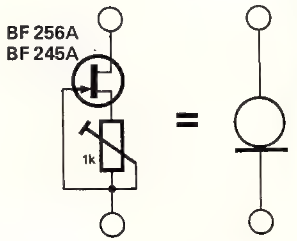
Here is a technical question we often hear: 'I have built a Junior Computer and everything functions perfectly. After a short time, however, the ICs become very warm and I switch the computer off again, in order to play it safe. I cannot find any explanation for this problem because everything operates perfectly. Can you help me?'
Yes, we can; no need to panic! It is perfectly normal for ICs particularly bipolar digital ICs such as TTL, to become very warm in operation. These ICs draw considerable power which is finally dissipated as heat. An example is the common TTL IC 74145. Typical dissipation for this device is 215 mW and approximately 360 mW maximum; this is in the quiescent state with unloaded outputs. When these are loaded the dissipation is even higher. Since the area of the IC package is relatively small, the IC becomes very warm indeed. This is no problem, however; it is rated appropriately and operates perfectly even at ambient temperatures of up to 70°C. When the computer is installed in a housing, care should be taken to provide ventilation slots for the heat to dissipate. In the event of doubt regarding the temperature rise of ICs, the data-sheet should be consulted: an IC with a maximum dissipation of 10 mW, for instance, should not exhibit noticeable temperature rise.

High quality tape playback pre-amp

Circuit no. 46 from the summer circuits edition of 1982. The circuit shown for cassette recorders can be modified as follows to cater for reel-to-reel tape recorders.
Tape speed 4.75 and 9.5 cm/s:
R4 = 39 k
Tape speed 19 and 38 cm/s:
R4 = 22 k
Everything else remains unchanged.

FET used in place of a Norton diode

Rare components, such as Norton diodes, often cause procurement problems that are very discouraging when one is faced with a construction project. Especially when the project concerned is as interesting as a V-FET amplifier (e.g. Elektor July/August 1980).
Necessity being the mother of invention, ingenious readers had the idea of replacing these expensive constant-current diodes by a current drive circuit using transistors 'or the like'. The only question is 'how'? We have found a solution: see figure 1. Depending which Norton diode is to be replaced, the constant current of this substitute circuit should be set by means of the trimmer potentiometer. The type designations of Norton diodes indicate the current: CR 200 = 2 mA, CR 390 = 3.9 mA, CR 470 = 4.7 mA and so on . . .



82185-1

Figure 1. Norton diodes replaced by FET current source.

Low-noise microphone preamplifier

Super low-noise preamplifier for magnetic cartridges — Elektor July/August 1982, page 7-72. A super low-noise preamplifier is also useful in conjunction with microphones, after correcting it to obtain a flat frequency response.
C1 = 1 n, R1 = 1 k, R14 = 390 Ω, C4, C5 = 100 p, C6, C7 and R17 are discarded. With 0.5 mV at its input, the preamplifier delivers approximately 200 mV at its output; it is suitable for dynamic microphones, it has a flat frequency response and still exhibits very low noise.

Adapting a potentiometer

In circuits, the resistance value of a potentiometer usually establishes the adjustment range of a (physical) quantity. With a typical potentiometer tolerance of ± 20%, it is possible that the adjustment range of a potentiometer is not sufficiently precise. In these situations it can be 'adapted'. Here is an example: voltage adjustment for the Elektor precision power unit of September 1980. A section of the circuit is illustrated *showing potentiometer P2, which is used to adjust the output voltage. The relationship between potentiometer value and output voltage in this case is very simple: 1 V output voltage per kilohm. To set the adjustment range to precisely 25 V, the resistance value of the potentiometer at its maximum must be as close to 25 kilohm as possible. Before going out to hunt for an extremely expensive, precision potentiometer, one should consider adapting P2 as follows:*

Use a 47 k potentiometer for P2 and connect a 100 k trimmer in parallel (see figure 2b); with the

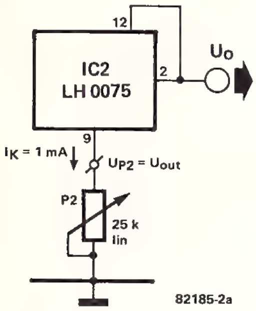


Figure 2a. Section of circuit of a precision power unit with an LH 0075. The value of P1 determines the highest output voltage and should be as close to 25 k as possible.

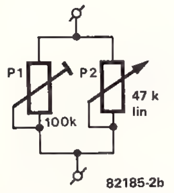


Figure 2b. The value of the potentiometer can be set precisely by connecting a trimmer in parallel.

potentiometer set to its maximum, adjust the trimmer to obtain an output voltage of exactly 25 V. As usual, there are also disadvantages:

1. The relationship between wiper travel of the potentiometer and output voltage is no longer linear (no problem in this case, because the voltage is indicated by the integral voltmeter).

2. If the potentiometer is used as a voltage divider, a greater resistance value also signifies higher internal resistance (not applicable in this case, because the potentiometer is connected as a variable resistor).

If the resistor of the potentiometer is only slightly higher than its rated value (i.e. up to +20%), the exact value can be obtained by adjusting a trimmer of a considerably higher value (factor of 10-20) in parallel. The disadvantages mentioned no longer apply, because the linearity and internal resistance only vary slightly.

Operating life using a 9 V battery

Small circuits with a low current consumption are often powered by a 9 V battery (IEC 6F22). In the descriptions of these circuits one sometimes encounters an approximate figure for the service life of the battery. How are these figures obtained?

This is a good question, considering that the capacity is not indicated on the battery not on its packaging. However, one can find the data in the manufacturers' technical literature, at least for alkali-manganese batteries; for example, in the very interesting 'Duracell guidelines' from Mallory. The rated capacity quoted is 500 mAh when discharged over a 750 Ω resistor, down to a terminal voltage of 4.8 V. The diagram shows the voltage curves for various loads. The capacity figures for 'normal' 9 V batteries, i.e. zinc-carbon systems, are not so clear. Their service life (available capacity) greatly depends on storage life, discharge current and type of discharge. However, in order to be able to make a qualitative statement, there are discharge tests specified by IEC, e.g. the illustrated 'pocket calculator test' which specifies a daily discharge of 30 minutes over a 180 ohm load resistor. The standard 9 V battery tested here provides nearly 6 hours of operation with a terminal voltage of 5.4 V. The capacity of a 'super dry battery' is slightly more than 8 hours in this test. In a 'radio test' (4 hours daily into 900 ohms) the operating life is approximately 40 hours (standard) and 50 hours (super). As estimates of capacity in mAh one can take approximately 200 to 350 for the pocket calculator test and 300 to 400 mAh for the radio test. In the case of a continuous discharge with high currents (e.g. into 180 ohms) on the other hand, not much more than 50 mAh can be expected because the battery does not have an opportunity to regenerate during intervals.

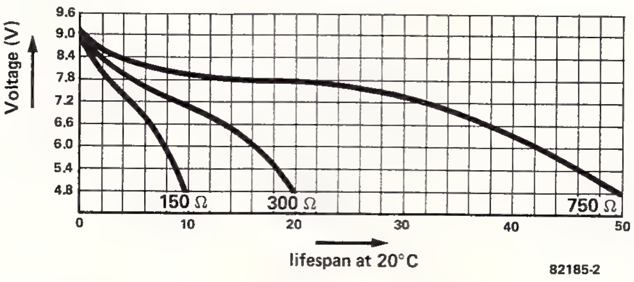
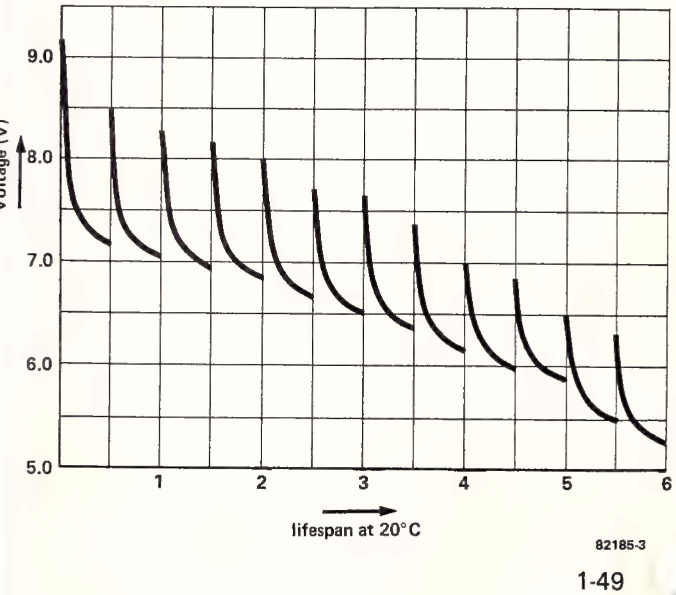


Figure 3. Typical discharge curves for a 9 V alkali-manganese battery (Mallory, IEC 6LF22).

Data and pin assignments, standard semiconductors

Elektor uses the same type designations in all editions for the standard semiconductors of the various manufacturers; for example, 741 instead of µA 741, LM 741, RC 741 and so on. The manufacturers' identification letters are dropped. This can be found under the heading 'Decoder' in every edition of Elektor. Sometimes, however, there are deviating characteristics (data) in addition to the manufacturers' letters. Are these also dropped? The answer is yes. If we specify a 'neutral' type designation, it means that the circuit is designed for the version with the 'more modest' data (e.g. smallest supply voltage range). If one uses an IC with improved characteristics from another manufacturer, there are no problems. Obviously the pin assignments must be the same! A little care must be taken with the 'TUPs' and 'TUNs' (terms created by Elektor). Not all transistors of the BC family, whose data allow them to be used as TUP or TUN without any problems, have the same pin assignments. Those types indicated in 'Decoder' can be relied on. This only applies to cases in which the manufacturer keeps to the 'Pro-Electron' agreement, which is not always the case. We recently came across a BC 516 with interchanged electrodes. Fortunately the manufacturer had marked the electrodes, so that one could at least identify them (during fault-finding, of course!).

Figure 4. Typical discharge curve for a standard 9 V zinc-carbon battery (IEC 6F22) in the 'pocket calculator test' of IEC: daily discharge of 30 minutes over a 180 ohm load resistor.



Fourier synthesis

An invitation to investigate, improve and implement imperfect but interesting ideas.

from an idea of
E. Muller

In 1822 a french mathematician came forward with an interesting mathematical expression which seems to fit the bill as far as sine-wave forms are concerned. Obviously his thoughts were not on electronics but on the complex problems relating to thermal conduction. Even so they are still relevant today in the field of electronics.

By definition the 'Fourier Transform' is a mathematical expression relating the energy in a transient to that in a continuous energy spectrum of adjacent frequency components. This gives us the Fourier Analysis which is termed as a method for determining the harmonic components of a complex periodic wave function. Conversely the principles can be applied to create wave-forms, ideal for music synthesisers.

With the help of a few examples we will explain how to apply the theory to produce exactly the wave-form wanted. The article does not go so far as to show actual working circuits, but sticks to block diagrams which should stimulate the urge to experiment.

Complex sound waves (sine waves) are composed of a fundamental frequency plus harmonics. As most of you know harmonics are oscillations of varying amplitude which are integral multiples of the fundamental frequency. If we then add the possibility of varying phase, the resulting characteristics are extremely complex.

For a periodic signal the Fourier expression is:

$$f_{(t)} = a_0 + 2(a_1 \cos 2\pi\frac{t}{T} + a_2 \cos 2\cdot 2\pi\frac{t}{T}\ldots) + 2(b_1 \sin 2\pi\frac{t}{T} + b_2 \sin 2\cdot 2\pi\frac{t}{T} + \ldots)$$

In a more compact and simpler form:

$$f_{(t)} = a_0 + 2\sum_{h=1}^{\infty}[a_h \cos 2\pi\frac{t}{T} + b_h \sin 2\pi\frac{t}{T}]$$

1

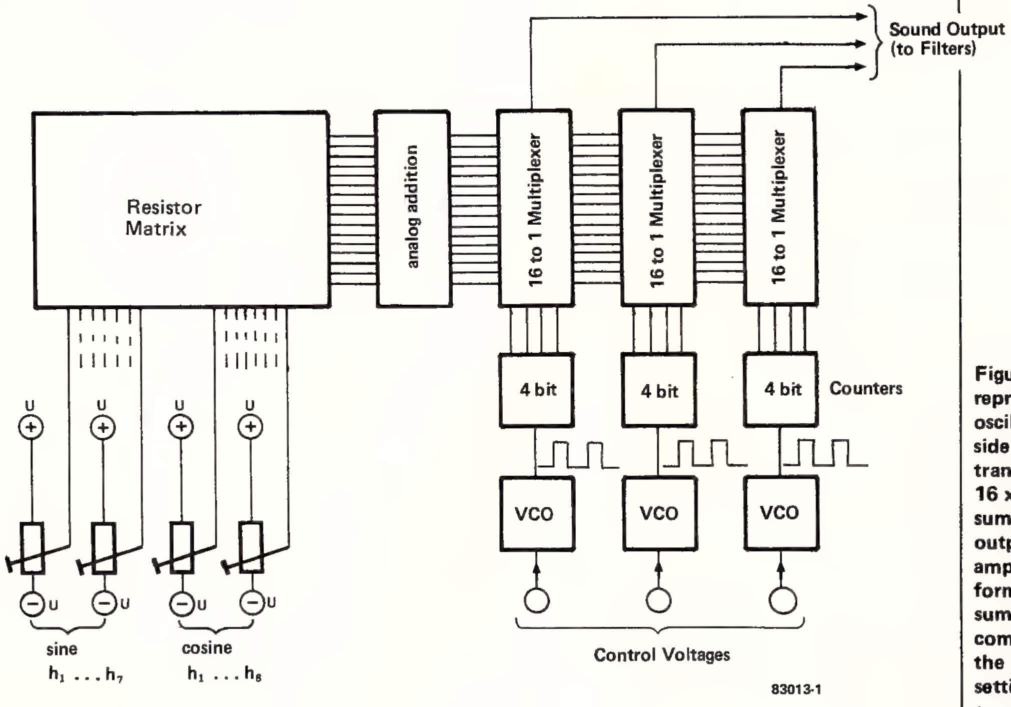


Figure 1. A block diagram representing a Fourier oscillator. On the left hand side is the Fourier transformer consisting of a 16 x 16 matrix and a summing amplifier. At the output of the summing amplifier appears a wave-form comprising of the sum of the sine and cosine components determined by the potentiometers settings. The multiplexer ensures the frequency is one determined by a VCO.

2

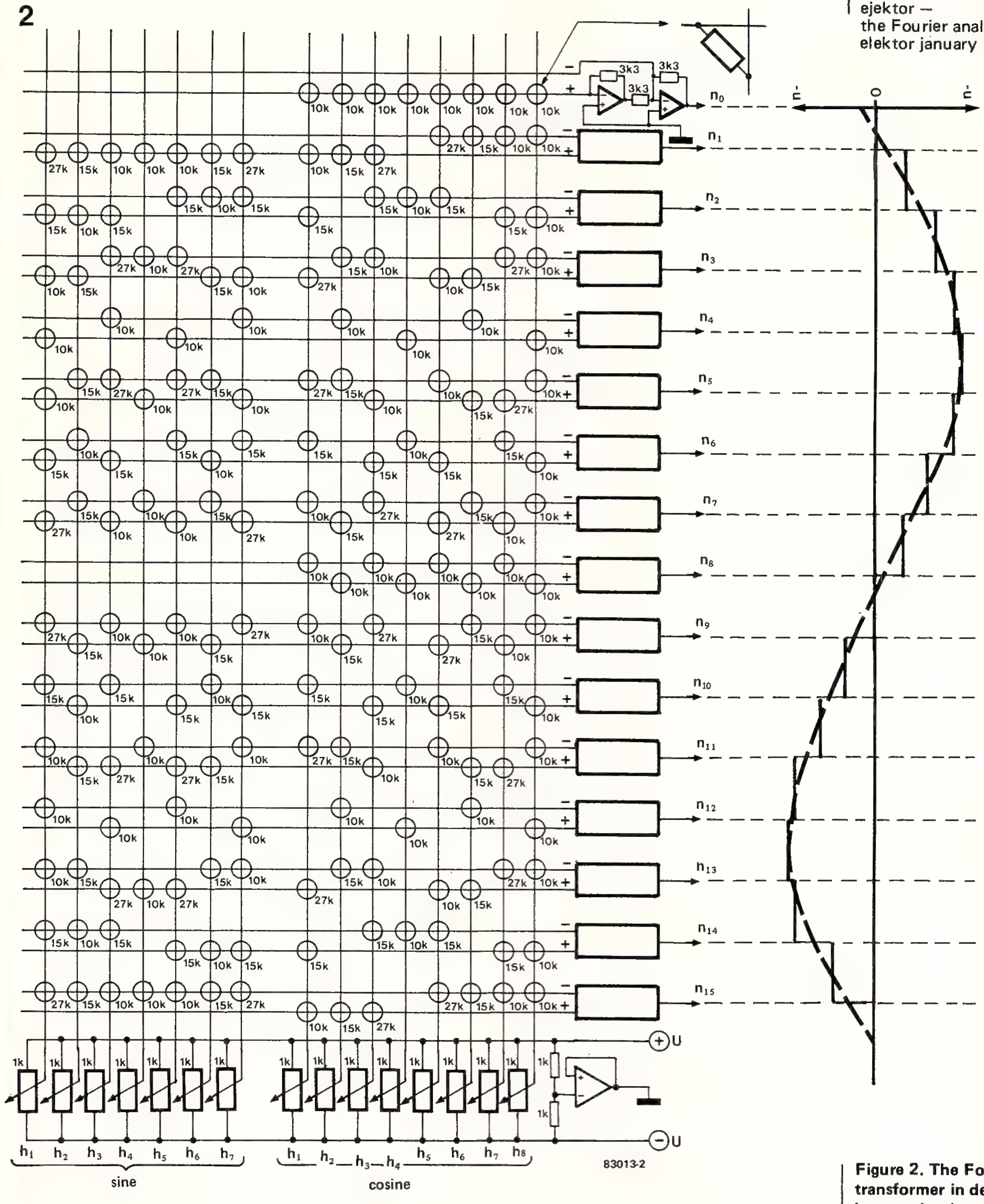


Figure 2. The Fourier transformer in detail. Each intersection has a resistor connected between the vertical and horizontal lines.

It is possible to extend these expressions infinitely in terms of sine and cosine components. In effect each harmonic conforms to a sine and cosine term, with the amplitude determining the phase relationship. It is theoretically possible to add an infinite number of harmonics, but that would need a piece of paper three miles long or more! In practice we have to restrict the situation using a more realistic number: eight or so.

Music synthesisers make good use of the Fourier principle; a sound source (oscillator) produces a signal with a certain number of harmonics, some of which are then taken out by a voltage controlled filter (VCF).

If we do not take into account the resonance factor of the filters we can assume that the final tone (waveform) is composed of a fundamental frequency with some of the original harmonics either taken away or attenuated.

In any acoustic instrument the same thing happens but in an analogue way. A guitar string, for instance, produces a tone (with harmonics) which is then amplified by the wood and sound box (resonance). Not all of the harmonics produced are treated in the same way; some are attenuated more than others and some are amplified in varying degrees. As the wood ages and the instrument is used more frequently the

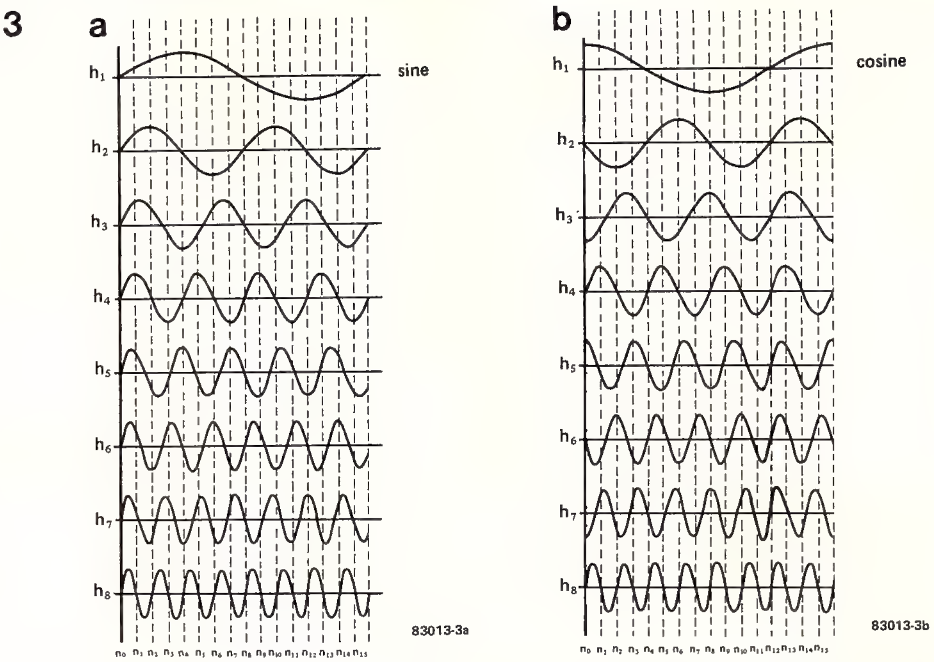


Figure 3. The sine (3a) and cosine (3b) components of the 16 outputs of the matrix. When the sine curve of the eighth harmonic (h8) crosses the zero point there is no result produced at the outputs.

molecular structure of the wood changes (and therefore its resonance factor), in turn altering the overall tone produced. The human voice undergoes the same treatment; the vocal organs in the larynx produce a tone, with the resonance and amplification being effected by the mouth and nose cavaties.
It is certainly possible to realise a complex filtering system electronically. But, as the final tone is determined by the original, what is the use of filtering out non existing harmonics from a square-wave oscillator. What is needed is a reversal of this approach; a final complex signal constructed from a fundamental with simple signals superimposed upon it.
Figure 1 shows the block diagram of a proposed oscillator 'a la' Fourier. The static Fourier transformer is composed of potentiometers, a resistor matrix and a summing amplifier. The potentiometers supply the sine and cosine components. These are fed via the matrix to the summing amplifier which in turn delivers an analogue signal composed of the first eight available harmonics. This collective signal is sampled by a 16 into 1 multiplexer which produced the definitive waveforms needed. The multiplexer is controlled by a square-wave signal generator (VCO). In other words the final signal is not determined by the Fourier transformer but by the frequency of the VCO. To obtain a chorus effect quite a few multiplexers and VCOs are required, the signals being further processed by voltage controlled filters (VCFs) and envelope generators (ADSRs).

Figure 2 shows the resistor matrix in greater detail. Each intersection has a resistor connected between the vertical and horizontal lines. The matrix is arranged so that 16 inputs results in 16 transformed outputs. This allows the possibility to create 8 harmonics of differing amplitude and phase, each being independant of the others. The sine and cosine functions (terms) are summed to produce a composite analogue signal. The amplifier is composed of two op-amps connected so that the horizontal lines of the matrix constitutes a virtual earth. The potentiometers only vary the voltage potential on the vertical lines. Therefore the current flowing through the resistors will depend on the changes in voltage level being fed to earth via the vertical lines. The currents are summed by the op-amps to produce an output voltage. The great advantage of using the virtual earth system is that the potentiometers do not interact or influence each other.
To calculate the resistor values the formula to use is:

$$R = 10/\sin\frac{2\pi\cdot h\cdot n}{16}\,[\mathrm{k}\Omega]\ \text{c.q.}$$

$$R = 10/\cos\frac{2\pi\cdot h\cdot n}{16}\,[\mathrm{k}\Omega]$$

n is the channel number (0 . . . 15).
h is the harmonic (1 . . . 8).
A positive resistor value means it should be applied to the positive input of the summing amplifier and a negative value to the negative input. The circuit at the output gives a sinewave (or a cosine) of the corresponding harmonic having the same amplitude. In order to explain this fully we have drawn the sine component of the first harmonic at the output. By varying the setting of several potentiometers we produce the sum of a number of sine and cosine components. Figure 3a represents the sine, and 3b the cosine parts of a harmonic (h1 . . . h8). The potentiometer controlling the sine-h8 can be omitted. The individual waveforms of the 16 channels will then intersect the zero point of the h8 harmonic with no result being produced at the outputs.
How to use the Fourier oscillator is left to the readers discretion as this article is meant as an introduction to the theoretical aspects from which experimentation can grow.
The potentiometers can be replaced by other types of voltage sources (fixed or variable). With this in mind we suggest the use of the graphic oscillator circuit from the Elektor summer circuits issue 1982 Nr. 7-48.

The January edition of Elektor traditionally examines future trends and is something of an 'Elektoracle'. A particularly interesting topic is the continuing change in the field of entertainment electronics, especially audio. With the advent of digital techniques, the question is raised concerning the audio system of the future. There are many indications of future trends in high-fidelity techniques and technology.

tomorrow's music

hi-fi up to the end the century

The main factors affecting the change in hi-fi equipment techniques are: the market, current and future legislation and, last but not least, the electronic components industry with its innovative attitude.

This last factor is obviously the one that interests us the most. The advances in semiconductor techniques allow us to progress from the existing, digital control of many audio components, such as cassette recorders and FM tuners, to digital signal processing. Apart from the hardware in the form of electronic circuitry, the software now plays a part for the first time. Thus, for example, it is now practically impossible to build an FM tuner without software because all present tuning systems (frequency synthesisers) contain a microprocessor.

However, it is also true that the influence of the market and legislation on future audio techniques should not be underestimated. Experience shows us that the consumer by no means always accepts what the electronics specialist admires. The influence of legislation on technical developments becomes increasingly obvious. The future for video text, satellite reception, cable television and wideband communications largely depends on legislation, apart from the 'indirect' influencing factors such as standards and test requirements. This is therefore the framework for the future development of high-fidelity.

1

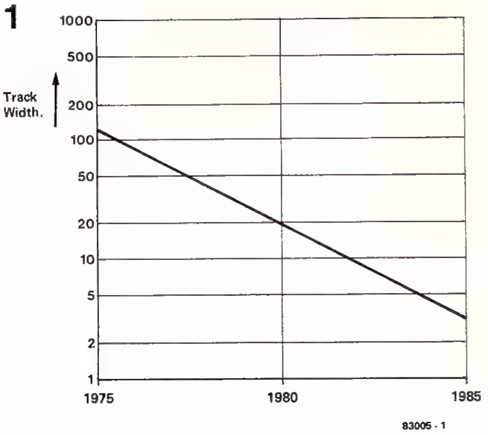


Figure 1. As the track width decreases the use of the compact disk becomes possible.

PCM — a basic innovation

The 80s are already the decade of digital audio techniques.

Now that the microprocessor has extensively taken over the control of functions in equipment, it is tackling the processing of the 'useful signal'. With the digital encoding of analogue signals, known as pulse code modulation (PCM), music becomes digital information like any other as far as the microprocessor is concerned. This is made possible by analogue-to-digital converters. Fast and powerful microprocessors handle this information in various ways: computing, storage, shifting back and forth. Since, to put it simply, computers do not make mistakes, the quality that goes in has to come back out; and that means without defects and distortion. Faults created in other 'departments' such as signal transmission by radio and cable or during storage on tape or disk, can be corrected.

These advantages which have been exploited for a long time in commercial telecommunications are now becoming accessible to audio systems. The final result will be a fully digital cascade: from the microphone in the recording studio, right up to the loudspeaker in the living room.

Tape and disk

It all started with the video recorder which evolved into a digital tape recorder, thanks to the PCM adapter. At present this is still the most widely used digital audio equipment available, but the scene is changing rapidly.

The digital audio disk is now with us. The Compact Disc, which is a development of the 'Laservision' video disk, provides one hour of stereo with a signal-to-noise ratio of > 90 dB, channel separation > 90 dB, distortion factor < 0.01%; wow and rumble are zero. See table 1 for a comparison: Signal-to-noise ratios of the components involved in a VHF radio transmission, including studio equipment!

The video recorder with PCM adapter as a recording and playback medium is only a temporary solution which is unlikely to survive for very long. One reason is that digital cassette recorders (both video and audio), are already in development and some Japanese manufacturers have already presented or announced their prototypes. In fact cigarette sized video recorders are already available in limited numbers. These PCM cassette decks use the well-proven compact cassette. In any case, vertical heads and longitudinal recording are employed, as with a normal cassette recorder. To begin with they will have up to 18 parallel tracks and a tape speed of 9.5 cm/s, which is twice the present standard. However, a study of the development of the head and tape technology used in video recorders (figure 1) allows one to draw the conclusion that it will be possible to record PCM signals in 'compact disc

Table 1

Microphone	70 – 75 dB
Mixing console	60 – 70 dB
Studio tape unit	54 – 58 dB
Record player	up to 70 dB
Direct-recording disk	72 – 76 dB
Modulation line	60 – 66 dB
VHF transmitter	60 – 65 dB
Hi-fi stereo tuner	60 – 65 dB

2

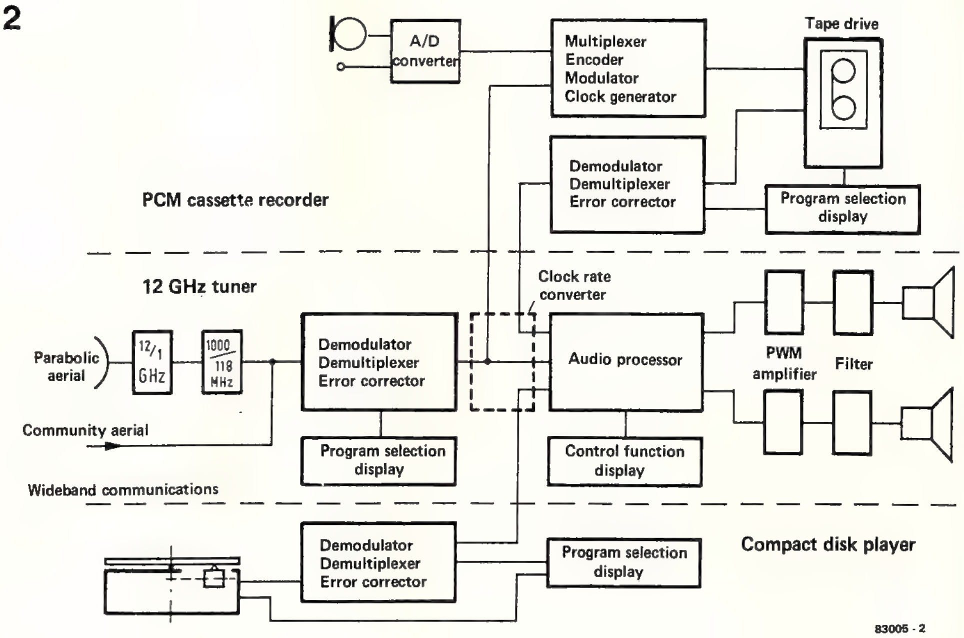


Figure 2. A stereo digital system.

quality' on a compact cassette at the standard tape speed of 4.75 cm/s. This will involve the use of special heads for so-called vertical magnetisation with only one, or possibly two, tracks per winding direction. Operation of digital cassette decks is considerably simpler than the analogue type. The many 'mimics' for recording level, premagnetisation, equalisation characteristics, noise suppression is dispensed with.

Digital stereo radio

The present FM transmission system in the VHF region as far as audio quality is concerned leaves a lot to be desired.
Some thought has been given to the possibility of digital audio-signal transmission in the VHF region, without changing the standard bandwidth. A change in transmission standards for VHF transmitters seems very improbable, on account of the question of compatibility with the millions of existing VHF receivers. The first step will therefore be digitisation of the VHF tuner, as is already the case with digitisation of the signal processing in television sets. The only part of a receiver that will still use analogue techniques will be the tuner. Demodulation and stereo decoding will be performed by a digital processor. It can be expected that this technique will improve the receiver with respect to distortion factor, noise and channel separation. Digitisation also helps to eliminate interference caused by multipath reception. Quality problems, however, will still be found at the VHF transmitter and modulation lines. Stereo radio programs may soon be available via satellite transmission, community aerial systems or wideband cable networks (fibre-optic cables). A single 12 GHz satellite channel with TV bandwidth can carry up to 16 stereo radio programs, and a single TV satellite has five of these TV channels.
The PCM tuner required for reception of these digital radio transmissions will then finally be the 'real' digital tuner, which will offer its owner the audio quality of the new digital era, together with every conceivable refinement (gimmick), such as voice-actuated command input.

Digital amplifiers

The digital amplifier of the future will consist of a fast signal processor which, with software support, will replace all classical controls such as volume, balance and tone, and a switching output stage. The latter will be in class D, better known as a PWM amplifier. The processor will perform the conversion from PCM to PWM. On account of the problem presented by spurious emission from switching output stages, it is likely that the amplifier will be installed in the loudspeaker box (active box). The future will also provide a solution for loudspeaker cables: fibre-optic cables. Of course, digital fans are not satisfied with the analogue PWM output stage (the information is contained in analogue form in the pulse width). They are dreaming of a digital-to-analogue power converter as an output stage.

3

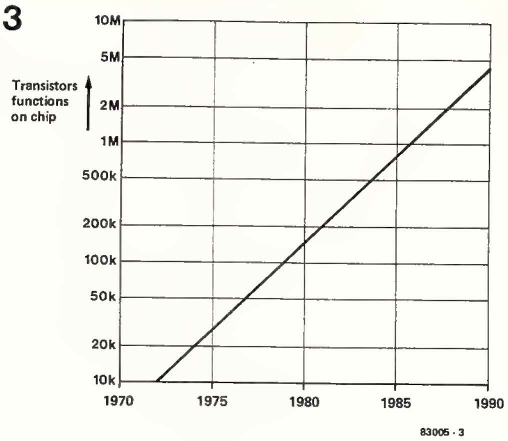
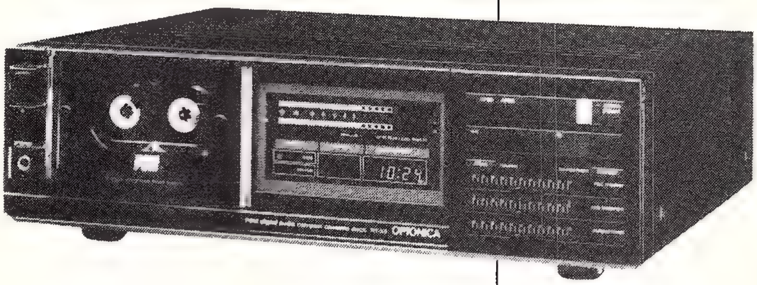


Figure 3. The ever increasing number of functions per chip.

The missing links: digital loudspeakers and microphones

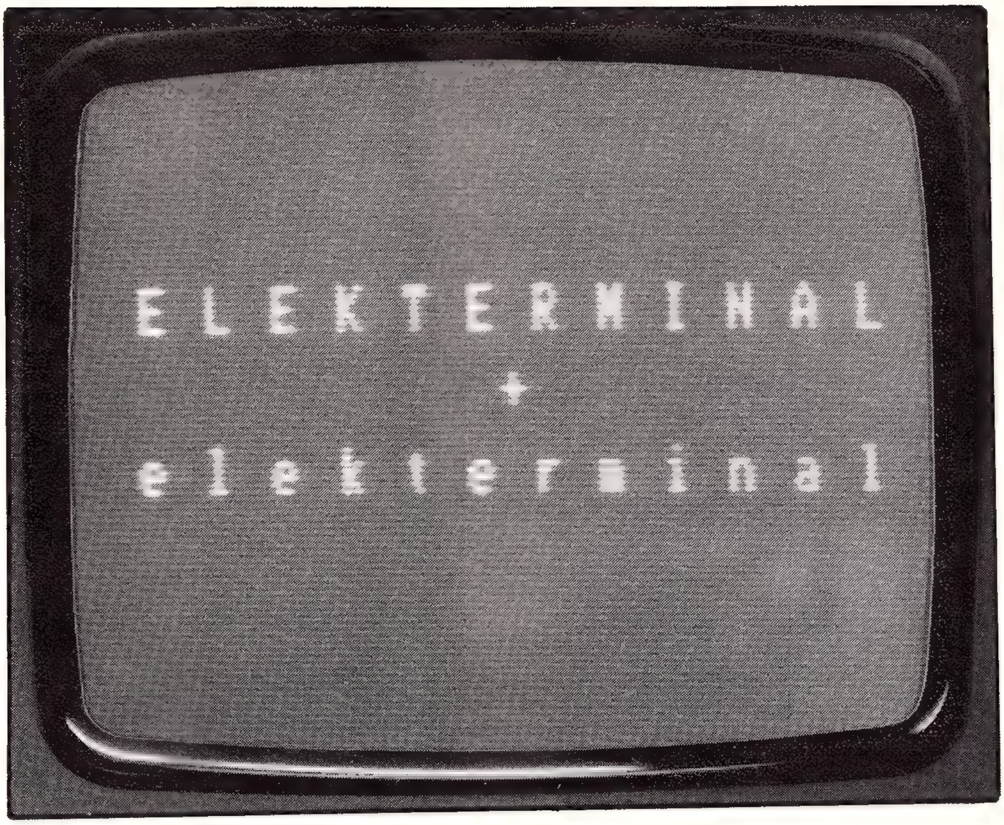
The analogue technique still seems to be the only one available for the beginning and the end of the audio system: no digital principle has yet been presented for microphones and loudspeakers. What is even worse is that the microphone preamplifier is also analogue and decisively affects the signal-to-noise ratio of the digital audio signal. A consolation is that analogue amplifiers are available with a signal-to-noise ratio of 100 dB.



The weak points still remaining are the loudspeaker, the room and listening habits (and facilities) of the consumer in his own four walls which are more or less permeable as far as soundwaves are concerned. The dynamic range of 85, 90 or more dBs offered by the signal is defeated here. Perhaps dynamic compressors (digital, of course) will become popular because the maximum volume that is practical in a living room prevents the listener from hearing the quiet music passages!

The real future: music semiconductors

Almost all the components indicated in figure 2 can already be found in development laboratories. This includes, for example, the laser disk which can be used for recording and playback, and which could become a competitor to the digital cassette recorder. The real future lies in semiconductor music memories. *RAM and ROM instead of disk and tape.* ◄



D. Paulsen

**Page extension for the Elekterminal
Elekterminal width extender
High-speed readout for the Elekterminal
These are some of the extensions that were added to the Elekterminal since its introduction (1978). Now the ELEKTERMINAL becomes an elekterminal. Continuing with the series of extensions, this article presents lower-case, special characters and as a matter of interest, the umlauts for German and other languages (ä, ö, ü).**

lower-case and special characters on the Elekterminal

The Elekterminal was originally developed as a refinement for the '78 BASIC computer. This SC/MP BASIC system has a Tiny BASIC interpreter which can only handle upper-case and is relatively slow. Recent computer systems, such as the Junior System with BASIC Version 3.3 make greater demands of a terminal.

Change of IC

The character set of the Elekterminal is located in ROM IC11 = RO-3-2513 CGR-001. A total of 64 ASCII characters can be displayed in a 5 x 7 matrix with this character generator. So far these 64 characters have only been upper-case, with a few ASCII special characters.

Conversion to upper-case and lower-case is mainly achieved by replacing IC11 by a type 2716 EPROM. This IC must be programmed according to the hex dump in table 3 in order to contain the codes for displaying a total of 96 ASCII characters.

+ 1 bit

In order to display 64 ASCII characters the screen memory merely requires a width of 6 bits ($2^6 = 64$). For 96 characters, however, an additional bit is needed. Since this bit must also be stored, another 1024 x 1-bit memory IC must somehow be accommodated on the printed circuit board. Moreover, after readout from the RAM area, this seventh bit must be buffered. Since IC9 only has space for 6 bits, a TTL IC is required in order to solve the problem.

Thus three new ICs are needed to display 96 characters: a 2716 instead of the old IC11, an additional RAM IC of type 2102A4 and a flip-flop from a 74LS74.

Lack of space?

Where can the three ICs be accommodated? For the 2102 the answer is simple: this IC is simply soldered onto IC4 in piggy-back fashion, except for pins 11 and 12. Before soldering, these two pins are spread and later wired to the other ICs.

The best solution for the 2716 and the 7474 is to place them on a small perforated board. This additional board is soldered to the main board instead of the former IC11, using stiff wire.

Pin 12 of the additional RAM IC is connected to pin 2 of the 7474; pin 11 is connected to point B5 on the board (see circuit diagram in figure 1).

1

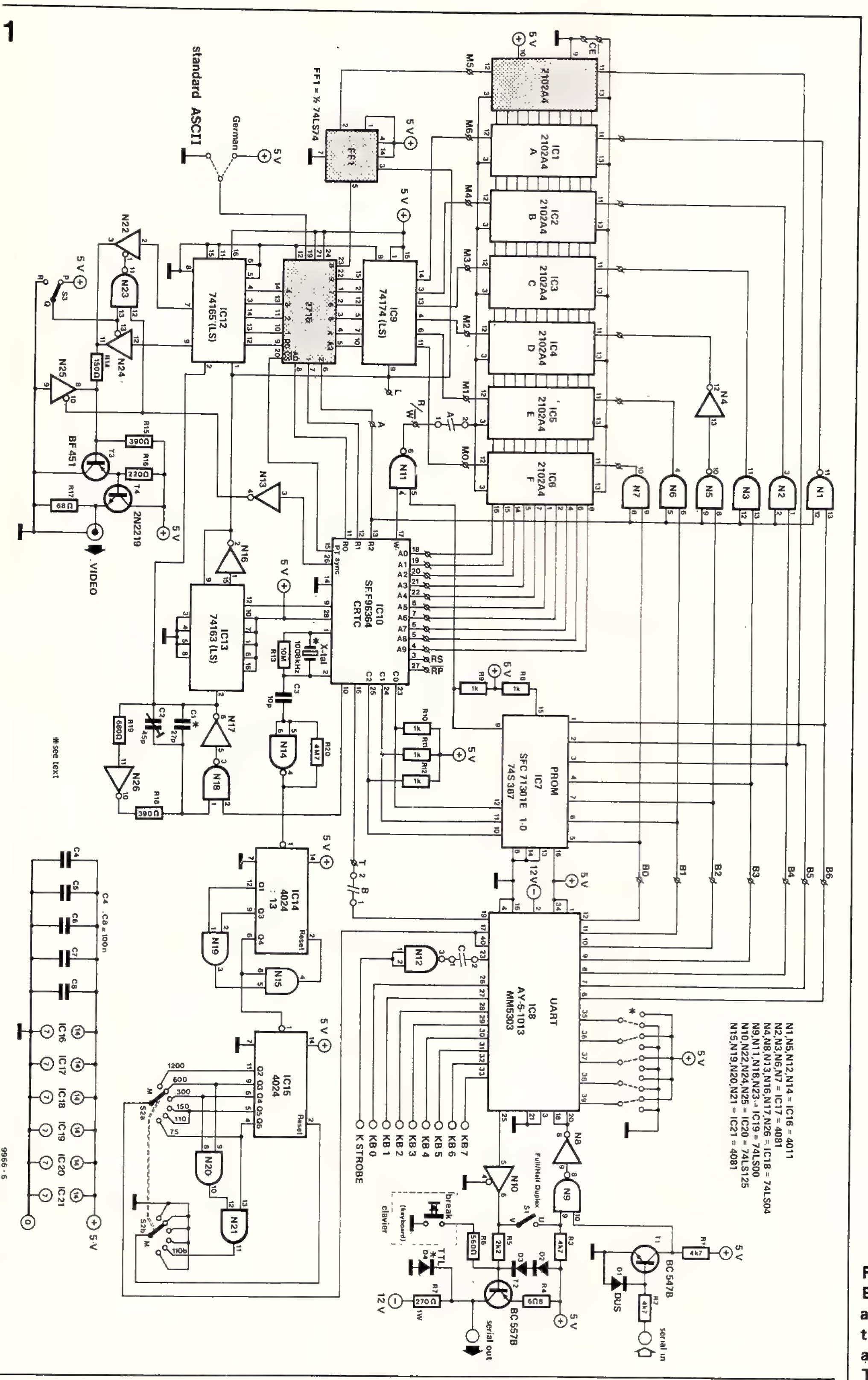


Figure 1. The extended Elekterminal. We have added RAM IC 2102, the flip-flop (1/2 7474) and a type 2716 EPROM. This replaces IC11.

Software

The EPROM contains two complete character sets: one is the German-English set and the other is the standard ASCII character set.
This is necessary because if the German set is used it means that some special ASCII characters must be omitted. Some computers need these special characters. For this reason, pin 19 of the EPROM can be used to switch to the international character set.
Table 1 shows the relationship between the ASCII code, internal Elekterminal code, absolute EPROM address and the corresponding characters.
Table 2 shows the locations for the German characters, just in case you need them.

Keyboard

There are no problems in connecting a standard ASCII keyboard or an ASCII keyboard with German characters to the extended Elekterminal.
The situation is somewhat different, however, when using the Elektor ASCII

2

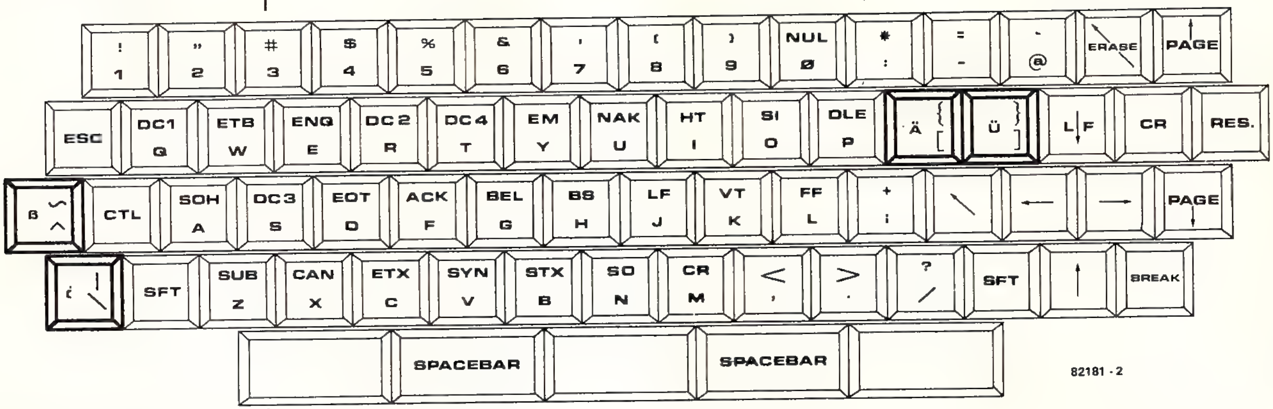


Figure 2. The ASCII keyboard of the Elekterminal. Two keys must be added here.

3

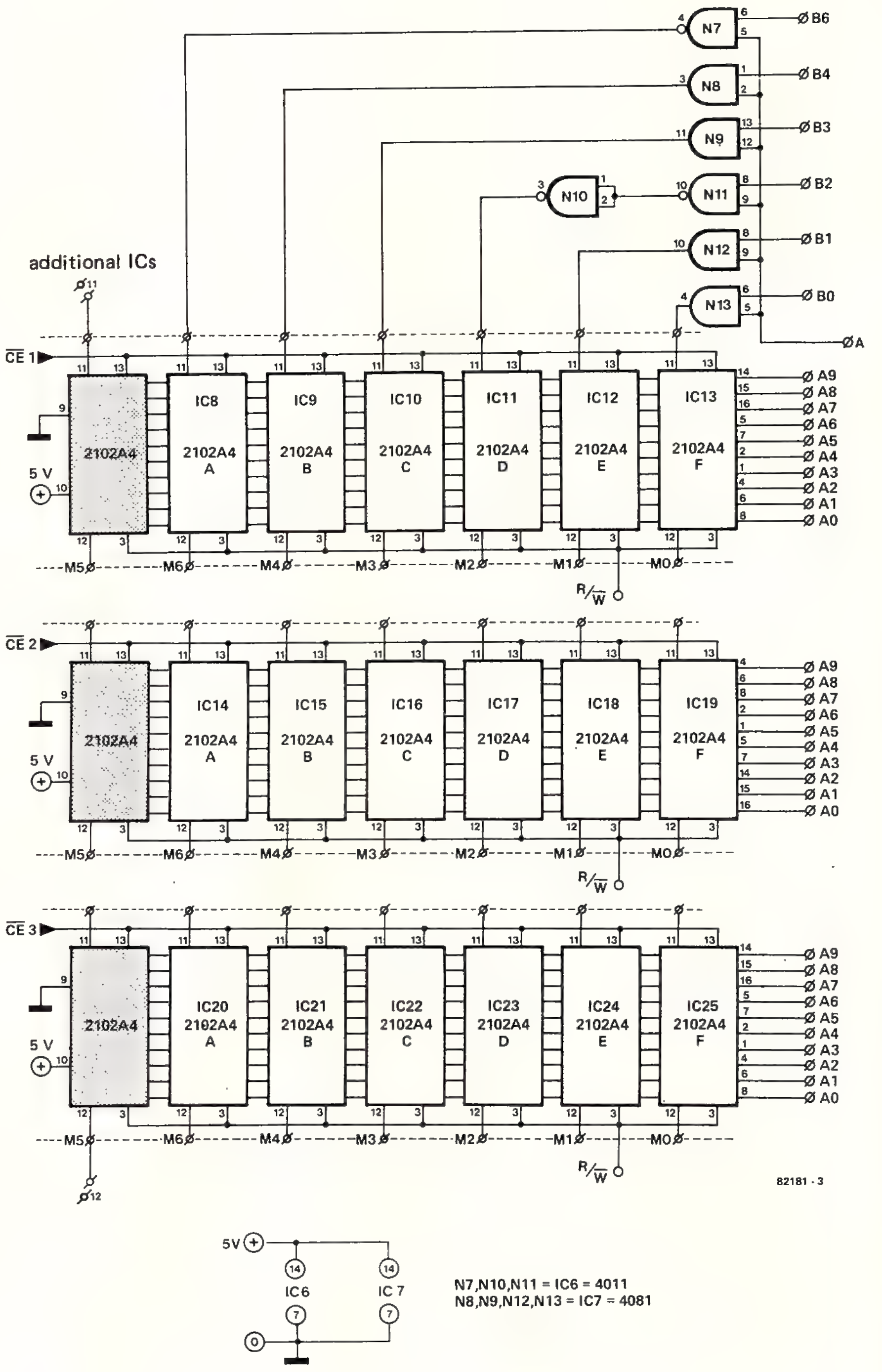


Figure 3. The circuit of the page extension with RAMs for the seventh bit.

Table 1

ASCII-Code	Internal Code	EPROM address	ASCII character
00 – 0F	40 – 4F	200 – 27F	ASCII 01 = Blank, rest free
10 – 1F	50 – 5F	280 – 2FF	free
20 – 2F	60 – 6F	300 – 37F	! to /
30 – 3F	70 – 7F	380 – 3FF	0 to ?
40 – 4F	00 – 0F	000 – 07F	@ to 0
50 – 5F	10 – 1F	080 – 0FF	P to –
60 – 6F	20 – 2F	100 – 17F	`to 0
70 – 7F	30 – 3F	180 – 1FF	p to DEL

Table 1. This table shows the relationship between ASCII codes, internal ASCII code (bit 6 inverted), the absolute EPROM address and the character displayed.

keyboard intended for the Elekterminal. Two keys are missing from this keyboard, which are needed to supply the ASCII codes for all characters. The two keys can be added to the circuit board for the keyboard as shown in figure 2. The Öö/| key is connected to pins 21 and 32 of the keyboard encoder IC and the ß/~ key is connected to pins 22 and 32.

The letters Ä and Ü can now be selected with the keys for braces and square brackets.

To be able to switch conveniently between the German and internal character sets, the lead from pin 19 of the 2716 on the video interface PCB can be connected to an additional changeover switch or pushbutton with changeover contact on the keyboard.

Table 2. By switching between the international and German ASCII character set, either special characters or the German characters are selected for some ASCII codes.

Table 2

ASCII Code	ASCII character	German version
7B	{	ä
5B	[	Ä
7C	|	ö
5C	\	Ö
7D	}	ü
5D	]	Ü
7E	~	ß
5E	^	^

Table 3. The EPROM must be programmed according to this listing. Two full character sets are contained in the hex dump — one with international characters and one with German characters.

7 bits for several pages

With the Elekterminal with the 4-page screen memory ('Page extension for the Elekterminal') memory space must also be provided for the seventh bit in the additional 3-page screen memory. In this case three more type 2102A4 ICs are needed.

As was the case on the video interface PCB, these ICs must be soldered onto ICs 8, 14 and 20 on the page extension in piggy-back fashion, except for pins 11 and 12.

The three pin 11s are interconnected with insulated hookup wire and this lead is then connected to pin 11 of the additional 2102 on the video interface PCB.

The same applies to the pin 12s: the three pin 12s are interconnected and then connected to pin 12 of the additional memory on the video interface PCB.

This terminates all modifications, extensions and improvements to the Elekterminal. ◼

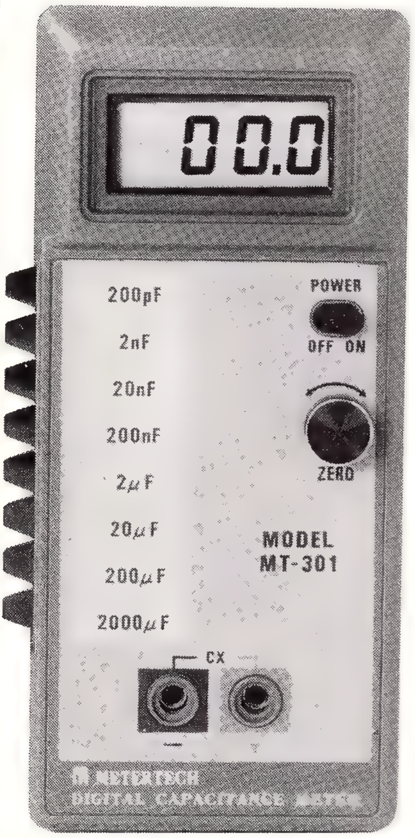
Literature:
- Elektor 11/78
  Elekterminal:
  ASCII keyboard
- Elektor 12/78
  Elekterminal:
  video interface
- Elektor 7/79
  Shift-lock for the
  ASCII keyboard
- Elektor 9/79
  Upper-case only with
  the ASCII keyboard
- Elektor 9/79
  Page extension for the
  Elekterminal
- Elektor 3/80
  Increased screen width
  with the Elekterminal
- Elektor 7/80
  'High-speed' readout
  for the Elekterminal

Table 3

```
        0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
D000   00 0E 11 17 15 17 10 0F 00 04 0A 11 11 1F 11 11
D010   00 1E 11 11 1E 11 11 1E 00 0E 11 10 10 10 11 0E
D020   00 1E 11 11 11 11 11 1E 00 1F 10 10 1E 10 10 1F
D030   00 1F 10 10 1E 10 10 10 00 0E 11 10 10 13 11 0F
D040   00 11 11 11 1F 11 11 11 00 0E 04 04 04 04 04 0E
D050   00 01 01 01 01 01 11 0E 00 11 12 14 18 14 12 11
D060   00 10 10 10 10 10 10 1F 00 11 1B 15 15 15 11 11
D070   00 11 11 19 15 13 11 11 00 0E 11 11 11 11 11 0E
D080   00 1E 11 11 1E 10 10 10 00 0E 11 11 11 15 12 0D
D090   00 1E 11 11 1E 14 12 11 00 0E 11 10 0E 01 11 0E
D0A0   00 1F 15 04 04 04 04 04 00 11 11 11 11 11 11 0E
D0B0   00 11 11 11 0A 0A 04 04 00 11 11 11 15 15 15 0A
D0C0   00 11 11 0A 04 0A 11 11 00 11 11 0A 04 04 04 04
D0D0   00 1F 01 02 04 08 10 1F 00 1F 18 18 18 18 18 1F
D0E0   00 00 10 08 04 02 01 00 00 1F 03 03 03 03 03 1F
D0F0   00 04 0E 15 04 04 04 04 00 00 00 00 00 00 00 1F
D100   00 08 04 02 00 00 00 00 00 00 00 0E 01 0F 11 0F
D110   00 10 10 1E 11 11 11 1E 00 00 00 0F 10 10 10 0F
D120   00 01 01 0F 11 11 11 0F 00 00 00 0E 11 1F 10 0E
D130   00 02 04 04 0E 04 04 04 00 00 0F 11 11 0F 01 06
D140   00 10 10 1E 11 11 11 11 00 04 00 0C 04 04 04 0E
D150   00 04 00 04 04 04 14 08 00 08 08 09 0A 0C 0A 09
D160   00 0C 04 04 04 04 04 0E 00 00 00 1A 15 15 15 15
D170   00 00 00 1E 11 11 11 11 00 00 00 0E 11 11 11 0E
D180   00 00 1E 11 11 1E 10 10 00 00 0F 11 11 0F 01 01
D190   00 00 00 0B 0C 08 08 08 00 00 00 0F 10 0E 01 1E
D1A0   00 00 04 0E 04 04 04 02 00 00 00 11 11 11 11 0F
D1B0   00 00 00 11 11 0A 0A 04 00 00 00 11 11 11 15 0A
D1C0   00 00 00 11 0A 04 0A 11 00 00 11 11 11 0F 01 06
D1D0   00 00 00 1F 02 04 08 1F 00 06 08 08 10 08 08 06
D1E0   00 16 19 11 1E 11 1E 10 00 0C 02 02 01 02 02 0C
D1F0   00 01 0E 10 00 00 00 00 00 00 00 00 00 00 00 00
D200   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D210   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D220   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D230   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D240   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D250   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D260   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D270   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D280   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D290   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D2A0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D2B0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D2C0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D2D0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D2E0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D2F0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D300   00 00 00 00 00 00 00 00 00 04 04 04 04 04 00 04
D310   00 0A 0A 0A 00 00 00 00 00 0A 0A 1F 0A 1F 0A 0A
D320   00 04 0F 14 0E 05 1E 04 00 18 19 02 04 08 13 03
D330   00 08 14 14 08 15 12 0D 00 04 04 04 00 00 00 00
D340   00 04 08 10 10 10 08 04 00 04 02 01 01 01 02 04
D350   00 04 15 0E 04 0E 15 04 00 00 04 04 1F 04 04 00
D360   00 00 00 00 00 04 04 08 00 00 00 00 1F 00 00 00
D370   00 00 00 00 00 00 00 04 00 00 01 02 04 08 10 00
D380   00 0E 11 13 15 19 11 0E 00 04 0C 04 04 04 04 0E
D390   00 0E 11 01 0E 10 10 1F 00 1F 01 02 06 01 11 0E
D3A0   00 02 06 0A 12 1F 02 02 00 1F 10 1E 01 01 11 0E
D3B0   00 07 08 10 1E 11 11 0E 00 1F 01 01 02 04 08 10
D3C0   00 0E 11 11 0E 11 11 0E 00 0E 11 11 0F 01 02 1C
D3D0   00 00 00 04 00 04 00 00 00 00 00 04 00 04 04 08
D3E0   00 02 04 08 10 08 04 02 00 00 00 1F 00 1F 00 00
D3F0   00 08 04 02 01 02 04 08 00 0E 11 01 06 04 00 04
D400   00 0E 11 17 15 17 10 0F 00 04 0A 11 11 1F 11 11
D410   00 1E 11 11 1E 11 11 1E 00 0E 11 10 10 10 11 0E
D420   00 1E 11 11 11 11 11 1E 00 1F 10 10 1E 10 10 1F
D430   00 1F 10 10 1E 10 10 10 00 0E 11 10 10 13 11 0F
D440   00 11 11 11 1F 11 11 11 00 0E 04 04 04 04 04 0E
D450   00 01 01 01 01 01 11 0E 00 11 12 14 18 14 12 11
D460   00 10 10 10 10 10 10 1F 00 11 1B 15 15 15 11 11
D470   00 11 11 19 15 13 11 11 00 0E 11 11 11 11 11 0E
D480   00 1E 11 11 1E 10 10 10 00 0E 11 11 11 15 12 0D
D490   00 1E 11 11 1E 14 12 11 00 0E 11 10 0E 01 11 0E
D4A0   00 1F 15 04 04 04 04 04 00 11 11 11 11 11 11 0E
D4B0   00 11 11 11 0A 0A 04 04 00 11 11 11 15 15 15 0A
D4C0   00 11 11 0A 04 0A 11 11 00 11 11 0A 04 04 04 04
D4D0   00 1F 01 02 04 08 10 1F 00 0A 00 0E 11 11 1F 11
D4E0   00 0A 00 0E 11 11 11 0E 00 0A 00 11 11 11 11 0E
D4F0   00 04 0E 15 04 04 04 04 00 00 00 00 00 00 00 1F
D500   00 08 04 02 00 00 00 00 00 00 00 0E 01 0F 11 0F
D510   00 10 10 1E 11 11 11 1E 00 00 00 0F 10 10 10 0F
D520   00 01 01 0F 11 11 11 0F 00 00 00 0E 11 1F 10 0E
D530   00 02 04 04 0E 04 04 04 00 00 0F 11 11 0F 01 06
D540   00 10 10 1E 11 11 11 11 00 04 00 0C 04 04 04 0E
D550   00 04 00 04 04 04 14 08 00 08 08 09 0A 0C 0A 09
D560   00 0C 04 04 04 04 04 0E 00 00 00 1A 15 15 15 15
D570   00 00 00 1E 11 11 11 11 00 00 00 0E 11 11 11 0E
D580   00 00 1E 11 11 1E 10 10 00 00 0F 11 11 0F 01 01
D590   00 00 00 0B 0C 08 08 08 00 00 00 0F 10 0E 01 1E
D5A0   00 00 04 0E 04 04 04 02 00 00 00 11 11 11 11 0F
D5B0   00 00 00 11 11 0A 0A 04 00 00 00 11 11 11 15 0A
D5C0   00 00 00 11 0A 04 0A 11 00 00 11 11 11 0F 01 06
D5D0   00 00 00 1F 02 04 08 1F 00 0A 00 0E 01 0F 11 0F
D5E0   00 00 0A 00 0E 11 11 0E 00 00 0A 00 11 11 11 0E
D5F0   00 0E 11 16 11 11 16 10 00 00 00 00 00 00 00 00
D600   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D610   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D620   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D630   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D640   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D650   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D660   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D670   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D680   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D690   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D6A0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D6B0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D6C0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D6D0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D6E0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D6F0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D700   00 00 00 00 00 00 00 00 00 04 04 04 04 04 00 04
D710   00 0A 0A 0A 00 00 00 00 00 0A 0A 1F 0A 1F 0A 0A
D720   00 04 0F 14 0E 05 1E 04 00 18 19 02 04 08 13 03
D730   00 08 14 14 08 15 12 0D 00 04 04 04 00 00 00 00
D740   00 04 08 10 10 10 08 04 00 04 02 01 01 01 02 04
D750   00 04 15 0E 04 0E 15 04 00 00 04 04 1F 04 04 00
D760   00 00 00 00 00 04 04 08 00 00 00 00 1F 00 00 00
D770   00 00 00 00 00 00 00 04 00 00 01 02 04 08 10 00
D780   00 0E 11 13 15 19 11 0E 00 04 0C 04 04 04 04 0E
D790   00 0E 11 01 0E 10 10 1F 00 1F 01 02 06 01 11 0E
D7A0   00 02 06 0A 12 1F 02 02 00 1F 10 1E 01 01 11 0E
D7B0   00 07 08 10 1E 11 11 0E 00 1F 01 01 02 04 08 10
D7C0   00 0E 11 11 0E 11 11 0E 00 0E 11 11 0F 01 02 1C
D7D0   00 00 00 04 00 04 00 00 00 00 00 04 00 04 04 08
D7E0   00 02 04 08 10 08 04 02 00 00 00 1F 00 1F 00 00
D7F0   00 08 04 02 01 02 04 08 00 0E 11 01 06 04 00 04
```

LCD digital capacitance meter

The Metertech Model MT 301 is a low cost hand held digital capacitance meter. Battery operated with a bold 0.5" 3½ digit liquid crystal display permitting a wide measurement range from 0.1 pF to 2000 μF across 8 ranges. Push button controls allow fast and easy operation whilst small size, robust construction and long battery life make the MT 301 truly portable. Supplied complete with battery, alligator test clips, spare fuse and instruction manual. Priced at £ 69 with a deluxe protective case available as an optional extra for an additional £ 6.



Centemp Instrument Co.,
62, Curtis Road,
Hounslow,
Middlesex.
Telephone: 01.894.2723.

(2522 M)

Microscribe

Terminal Technology, of Newport, Gwent, has launched what is probably the lowest cost and smallest general purpose computer terminal available on the market. Developed and manufactured in the UK, the Microscribe terminal is designed primarily as a desktop information retrieval tool. It can be used with any host computer, peripheral or network utilising the industry standard RS 232C serial interface at speeds up to 9600 Baud whilst supporting XON – XOFF protocol.

Weighing 500 gms and measuring only 190 x 140 x 26 mm, the Microscribe has an ergonomically designed full QWERTY keyboard with a single line alphanumeric LCD display of 16, 32 or 40 characters. The 8.7 mm high characters are formed from a 5 x 11 dot matrix to give upper and lower case with true descenders. Special graphics with an underline cursor are standard features.

The basic onboard storage capability of 160 characters can easily be expanded to 32,000 by the simple population of internal RAM. A memory protect feature keeps als data stored in RAM intact for 1,000 hours even when the rechargeable batteries are fully discharged. A cassette port allows for the transfer of unlimited amounts of data to and from ordinary cassettes or indication mini-cassettes.

The terminal is microprocessor based, with an elegant software routine that enables a dual operating mode to be selected via the keyboard. These modes are application oriented and enable the terminal to be used in either 'engineering' or 'executive' type environments. The engineering mode allows the user to capture and view all 128 ASCII characters, including control codes, whilst in the executive mode the terminal functions as a standard VDU.

Both NMOS and true CMOS versions are available to offer the user low cost or portability, with a battery operated version giving typically three to four weeks use between charges. A fully automatic contrast control enables high legibility and wide viewing angles to be maintained despite variations in voltage levels.

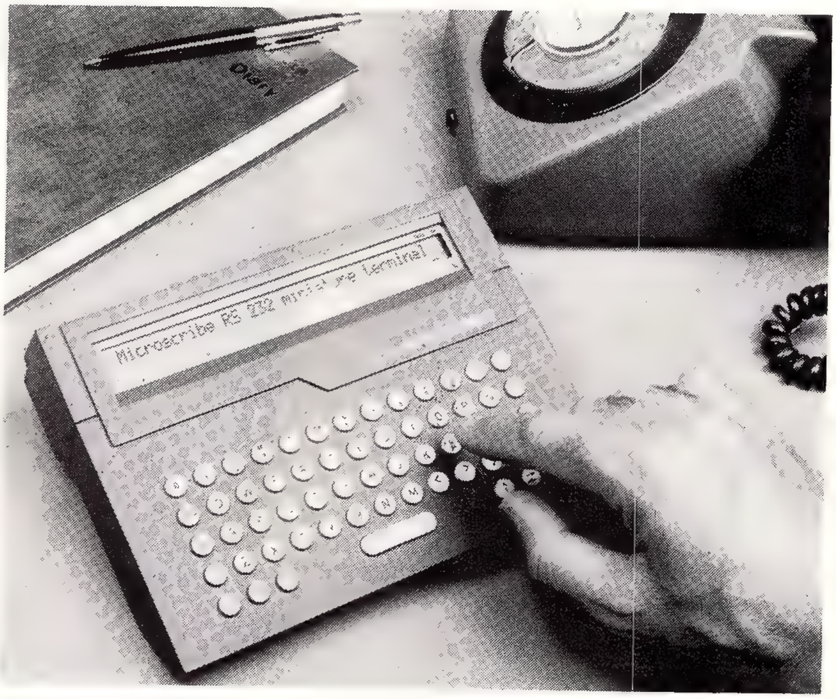
The software controlled keyboard uses conductive elastomeric technology and features full travel switches with excellent tactile response and selectable audio feedback.

An unusual feature of the terminal is the interactive set up procedure where the display prompts the user to set up the terminal's communication and operational parameters, and then accepts and retains the redefinition via keyboard commands.

The basic family of terminals will be followed in the very near future with an intelligent version containing a resident high level language, transforming the terminal into a powerful, portable computer, and a version dedicated to word processing.

Terminal Technology,
Clarence House,
Clarence Place,
Newport,
Gwent NPT 7AA.
Telephone 0633.214128/9.

(2515 M)



Mini Buzzers

Suitable for fire alarm, gas and fire detector, measuring automatic controlling devices, radio communication and numerous consumer product applications, the Murata piezo electric buzzer features high sound pressure with low power level, clarity of sound, small size and, light weight, high reliability and no noise due to the absence of contacts plus low cost. A full technical manual giving comprehensive information on the Piezo Electric Buzzer and its various applications and benefits is available from HB Electronics.

HB Electronics,
Lever Street,
Bolton BL3 6BJ.
Telephone: 0204.386361.

(2518 M)

elektor switchboard

CENTRONICS 737 printer. Perfect, unused at a fraction of the new price. £ 300, o.n.o. Tel: 021, 705,8459, evenings.

WANTED dual beam oscilloscope min 5MH3 in good working order. Max price £ 55.
J. Barrington,
25 Haslemere Gardens,
London N3.

ELEKTOR Piano 5 Octave SKA Kbd £ 225 ono. Watford Rhythm Generator £ 50 ono. Elektor Digital Delay £ 90 ono. 1 Extension Board. Dr. W.J. Philips, 20 Barcheston Road, Knowle, Solihull, West Midlands B93 9JS. Tel. Knowle 78488

T159 with PC 100C little used. E/E Library Module Magnetic cards Coding Pads. Full Documentation. First £ 250 secures. L.W.F. Bowen, 110, Lowther Street, Penrith, Cumbria CA11 7UW. Tel. 0768 62693

2x100 Watt SPEAKERS hardly used. 8 ohms 12 inch. £ 20 each or £ 30 for both. Also 3 Shugart Drives 5¼ inch. £ 80 each David Barnes, 76 Corkerhill P1., Glasgow G52 1RD. Tel. 041 883 1744

PAIR of **JENNINGS** 61 note C-to-C keyboards and 2 octave pedal boards with sundries: £ 120, will split. Tel: 0634-40464 (Newbury).

WANTED books on the principles/applications of ultrasonics. Also wanted: 40 kHz to 25 kHz transducers cheap. Tel: 0742-311191 after 4 pm (Sheffield).

PYE POCKETPHONES wanted, prefer RBO. Sale FDK Multi 750E £ 250 Mr. P.K. Djali, 26 Brooklands Crescent, Fulwood, Sheffield SIO 4GE

ELECTRO-TECH Low Noise Stereo Cassette Deck kit with drive mechanism and finished case — 80% built. Good value at £ 25. K.Y. Chang, 70, 1-up, Asley Street, Glasgow G3 6HW. Tel. 041 332 7695.

FOR SALE Junior Computer with Power Supply and books. Perfect working order £ 60. Phone Orpington 34982.

ELEKTOR TV Games Computer, built + joystick, both with case. £ 150 ono. Tel. 01 459 4653 evenings. Attn. Esan.

Sailor (Danish) 26D Marine TX, 2MHZ 11 channel, hybrid, QE05/40's output. Good condition £ 45 ono. + carriage. L.A. Wilkinson, 2 Cragside, Lower Contour Road, Kingswear, Devon TQ6 OAL.

TV 8 channel touch tune with infra-red remote control circuit diagrams and construction details £ 3.75. Mr. B. Ewan, 16 Fair Acres, Harwood, Bolton BL2 3NT.

WANTED: Mint copy machine — VIC20 or Sinclair Spectrum/ ZX81 Also IBM, DEC, Sirius or Osborne PC with accessories. R. Skoglund, N-2353 Stavsjø, Norway. Tel. +47 65 52 193

WANTED: Small quantity "C" Cores 100 W to 350 W for Audio PA transformers for PA amplifiers. H.E. Enfield, "Springtime", Withies Lane, Midsomer Norton, Avon BA3 2JE. Phone 412058.

WANTED: Oscilloscope, dual for single beam, must be in good order, reasonable prices please. Mr. A. McBride, 70 Larch Drive, Greenhills, E. Kilbride, Glasgow, Scorland.

NEED Jackson Bros. Ball Drive with Rim Drive Output Shaft, single hole mtg. Have Collins Mech. Filters to swap. David W. Burns, 4109 Queen Mary Drive, Olney, M.D., U.S.A. 20832

UK101 — 32x48, Cegmon, 8K, Res. Basic 4; 5, TK1T2, Codekit: Forth, as SMB, Exmon, Games on tape + books. Smart case. Cost £ 550 — £ 200.Tel. (0252) 54739.

I'd like to buy Pr. Specs, Manuals, Appl. & Software notes on NS INS 8073 & ZILOG Z8671 (CPU's W. BASIC-Debug Interpreter). Blazimir Mise, BScEE, Jurija Gagarina 42/25, YU-11070 Novi Beograd, Yugoslavia.

TEKTRONIX 535A Oscilloscoop with IA2 plug in. Good condition. Would swap for smaller Scope, not working considered. W. Joughin, 22 Birch Dale, Hythe, Southampton.

WANTED Scope tube no. DG7-32. Please ring 623 270 (Halton), 6 Rosemead, R.A.F. Halton, Aylesbury, Bucks.

FREE SPRUNG STEEL WIRE for polystyrene cutter 14 pin IC sockets 10 — £ 1.20 + SAE. I am looking for a CB set cheap. D. Martin, 6 Downland Gardens, Tattenham Corner, Epsom, Surrey.

ELEKTOR 16K RAM + EPROM Progr. + Super Board 2 + loads of extras — offers? Ring 0727 59397 evenings.

BASIC Micro (79075) £ 40. 4K RAM card £ 80 both for £ 100; both fully functional, with PSU and case add £ 25. Mr. L. Biddulph, 7 Albemarle Gardens, Gt. Bradfords, Braintree, Essex CM7 6UQ. (0396) 43308.

TELETYPE KSR33 v.g.c. PSU for I/F included £ 55. Also PSU's 5V-30A (small), 15V-7.5A Twin, 5V-20A, +—15V-3A Triple. £ 40 each. Phone Milton Keynes 582702.

FREE advertising for our readers!

Rules:

- Private advertisers only. No trade, no business.
- Full address or private telephone number; no post office boxes.
- Items related to electronics only. Software only when related to Elektor computer systems.
- Maximum length: 114 characters — letter, numeral, comma, space. etc. (not including address and/or telephone number).
- One advertisement per reader per month. To enforce this rule, a switchboard voucher will be printed each month.
- Elektor cannot accept responsibility for any correspondence or transaction as a result of a 'switchboard' ad, nor as a result of any inaccuracy in the text.
- Ads will be placed in the order in which they are received.
- We reserve the right to refuse advertisements, without returning them.

I am a private reader. I have read your rules and I enclose a valid switchboard voucher. Please place the following advertisement, free, in the next available space.

BLOCK CAPITALS PLEASE — ONE CHARACTER TO EACH BOX

Name and address:

Send to:

Elektor switchboard,
Elektor House
10 Longport
Canterbury CT1 2BR

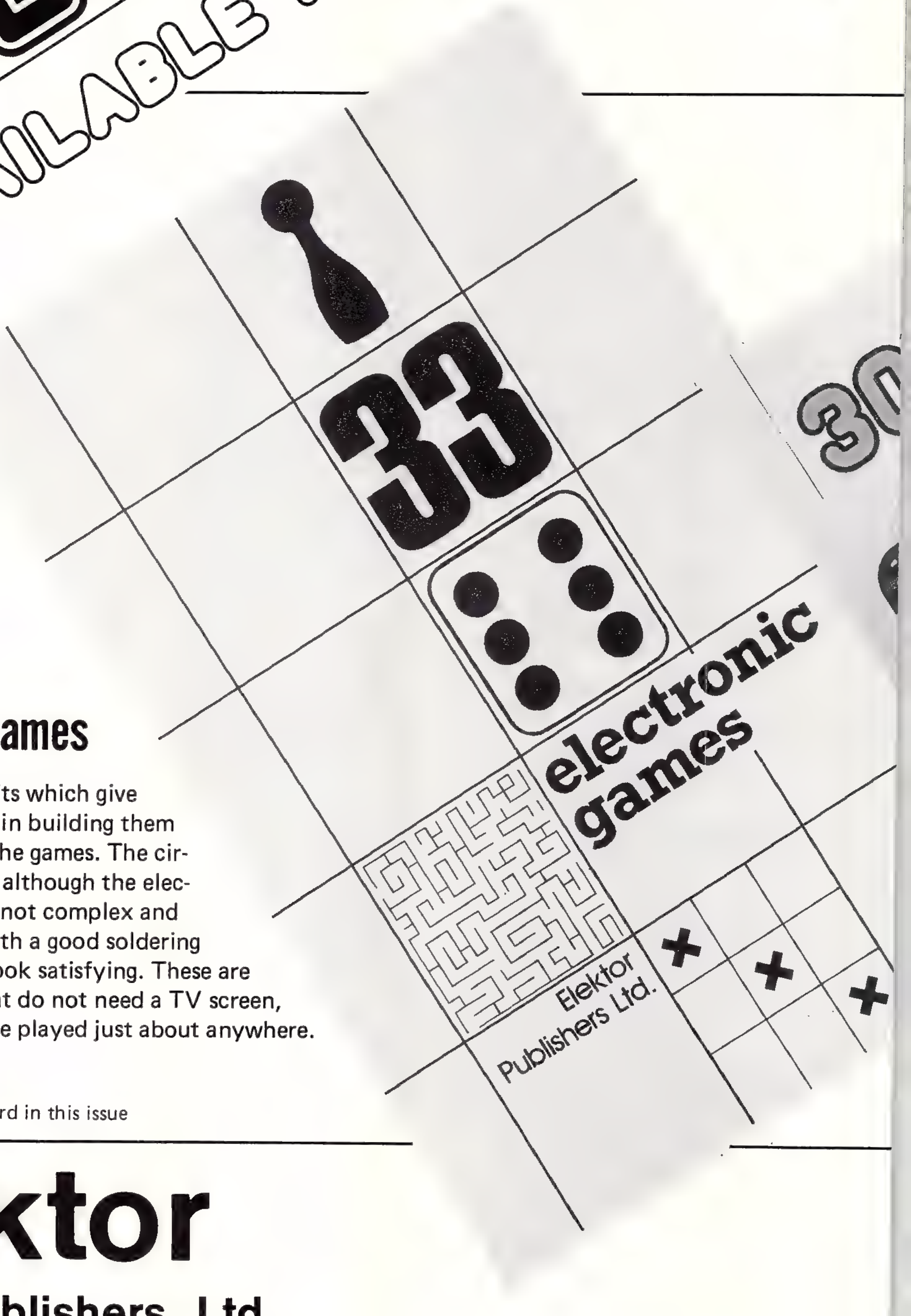
All advertisements *must* include the voucher printed here. They must be post-marked within the month indicated.

elektor switchboard January

NEW

AVAILABLE NOW

Two



33
electronic games

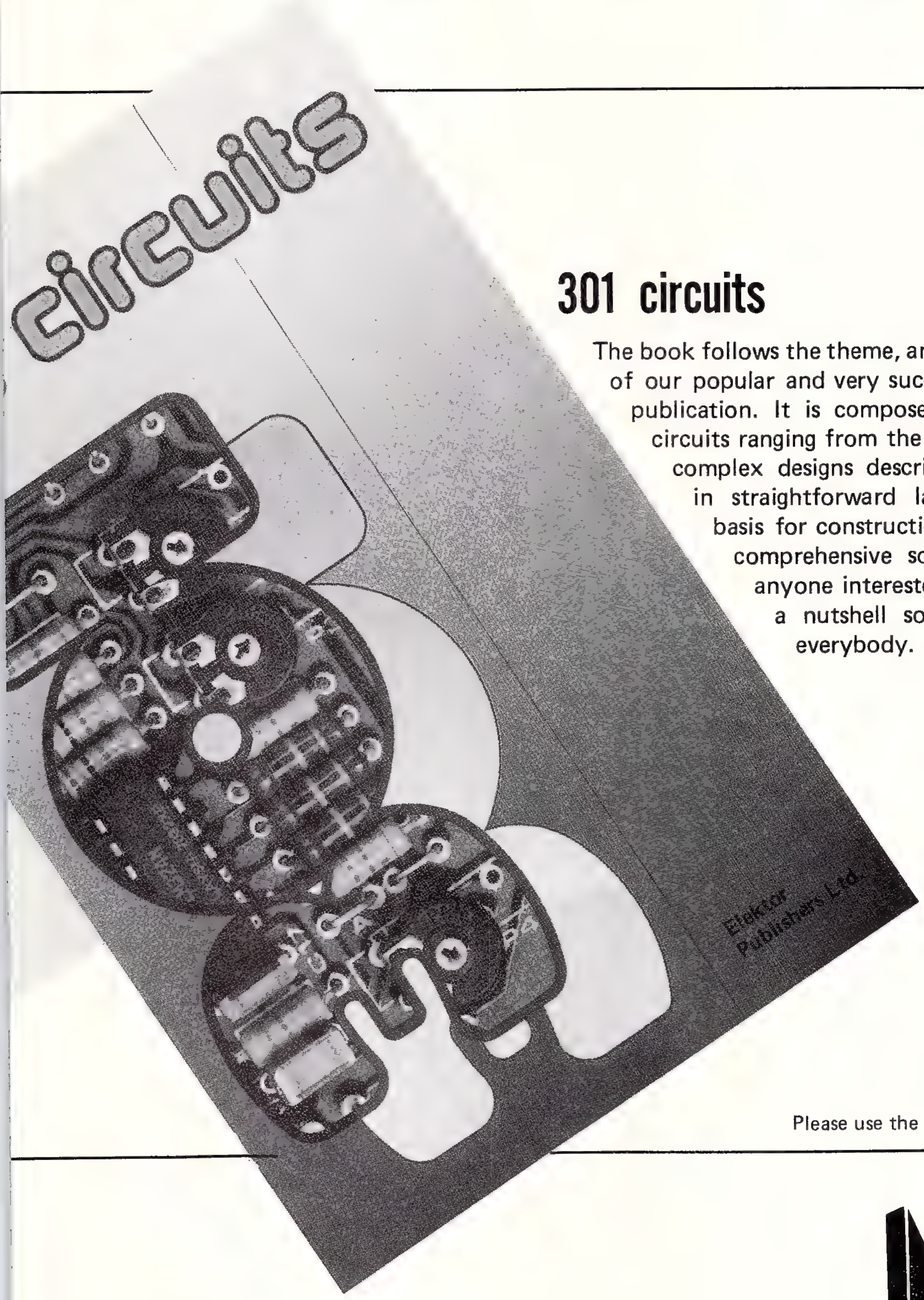
A selection of circuits which give as much enjoyment in building them as actually playing the games. The circuits are fascinating although the electronics involved are not complex and therefore anyone with a good soldering iron will find this book satisfying. These are electronic games that do not need a TV screen, and as a result can be played just about anywhere.

Please use the Order Card in this issue

elektor

Elektor publishers Ltd.
Elektor house 10 Longport
Canterbury CT1 2BR

new books from elektor



301 circuits

The book follows the theme, and is a continuation of our popular and very successful 300 circuits publication. It is composed of 301 assorted circuits ranging from the simple to the more complex designs described and explained in straightforward language. An ideal basis for constructional projects and a comprehensive source of ideas for anyone interested in electronics. In a nutshell something to please everybody.

Please use the Order Card in this issue

CRICKLEWOOD ELECTRONICS LTD

40 CRICKLEWOOD BROADWAY, LONDON NW2 3ET. Tel: 01-4520161 TELEX: 914977 CRIKEL G

SUPERIOR QUALITY CARBON FILM RESISTORS' HISTAB LOW NOISE

¼ W 10 Ω - 1MΩ 5% E24	2p
½ W 10Ω - 10MΩ 5% E24	3p
1 W 10Ω 10MΩ 5% E12	6p
2 W 10Ω - 10MΩ 5% E12	15p

METAL OXIDE/FILM RESISTORS

Very high thermal & electrical stability. Extremelu low noise

0.4 W 10Ω - 1MΩ 2% E24	5p
0 1 W 10Ω - 1MΩ 1% E24	8p

LOW OHMIC VALUE RESISTORS (½ W OR ¼ W)

0 22Ω B 2Ω E12	11p

WIREWOUND RESISTORS 5%

2 3 W 0 22Ω 330Ω E12	28p
4 7 W 0 47Ω - 6K8 E12	33p
10 11 W 1 0Ω 33K E12	37p

LOW NOISE ROTARY POTS

E3 Series

4 7K 2M Lin	32p
4 7K 2M Log	32p
As above with DP switch	80p
As above but stereo (no switch)	90p

MICRO-MINI 100V CERAMIC PLATE CAPS

5% or better

E12 Series

1pF - 10nF 7p

DISCOUNTS ON QUANTITY PLEASE PHONE

SIEMENS 63V MINI MONOLYTHIC CERAMIC

10nF	10p
22nF	10p
33nF	10p
47nF	10p
68nF	10p
100nF	14p

SIEMENS POLY-C 5% 7.5mm 250V CAPACITORS E12

1nF - 68nF	10p
82nF 150nF	15p

5% 7.5mm 100V CAPACITORS E12

100nF-180nF	12p
220nF 270nF	15p
330nF-390nF	20p
470nF-560nF	27p
680nF	32p
1μF (10mm)	35p

Complete range of other voltages & spacings in stock. Please phone

ICE MULTI-METERS

Microtest 80 £ 16.00

Supertest 680R £ 32.00

TANTALUM BEADS

1/35 V	17p
22/35 V	17p
33/35 V	17p
47/35 V	17p
68/35 V	17p
1 0/35 V	17p
2 2/16 V	17p
2 2/35 V	22p
3 3/35 V	22p
4 7/16 V	22p
4 7/35 V	24p
6 8/25 V	26p
6 8/35 V	25p
10/16 V	25p
10/35 V	34p
15/10 V	22p
15/25 V	32p
22/6 3 V	26p
22/16 V	32p
33/10 V	38p
47/6 3 V	43p
100/3 V	37p

Feedthrough Capacitor

1000pF 500V 7p

MINI FILM MULLARD TRIMMERS

1 4 5pF (800MHz)	23p
2 10 pF (600MHz)	27p
2 22pF (400MHz	29p
5 5 - 65pF (200MHz)	36p

630VDC 250VAC POLYESTER CAPS

10nF	12p
15nF	18p
22nF	18p
47nF	32p
100nF	35p
150nF	37p
220nF	40p

Fully enclosed Piher Pre sets

E 3 Series

100Ω 10M

Cermet 20 Turn Precision Preset:

50Ω, 100Ω,
200Ω, 500Ω
1K 2K, 5K,
10K 20K,
50K, 100K,
250K, 500K

99p eac'

Mini Vert	14p
Mini Horiz	14p
Standard Vert	17p
Standard Horiz	17p
Thumbwheel or ¼" Spindle for Standard Pre sets only	8p

160V Polystyrene Caps 5% or better

10pF 15pF,
22pF 27pF,
33pF, 39pF,
47pF 68pF,
100pF, 150pF
180pF 220pF,
270pF 330pF
390pF, 470pF,
680pF 820pF,
1nF, 1 5nF,
2 2nF, 3 3nF,
4 7nF, 10nF

12p each

C280 or Equiv Polyester Caps Radial Long Leads

10nF 15nF, 22nF, 33nF, 47nF, 68nF, 100nF	9p
150nF, 220nF,	11p
330nF, 470nF	16p
680nF, 1μF	24p
1 5μF, 2 2μF	44p

Veroboard 0.1" Copper Clad

2 5 × 3 75	72p
2 5 × 5	80p
3 75 × 3 75	80p
3 75 × 5	93p
2 5 × 17	2.50
3 75 × 17	3.30
4 79 × 17	4.20
VQ Board	1.50
Dip Board	3.25
Track Cutter	1.15
Pin Insertor	1.59
100 Pins	.50
Verobloc	3.70

Vero Wiring

Pen + Spool	3 00
Spare Spool	72p
Combs	6p

Ferric Chloride

60% Solution 250ml bottle £1 60

Quality Electrolytics

By Matsushita or Siemens

(other good makes may be sent only in the rare event of supply difficulty)

AXIALS

uFd	V	
.47	63	8p
.47	100	5p
.47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2 2	63	9p
2.2	100	11p
2 2	350	30p
3.3	25	10p
3 3	40	11p
3 3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
330	16	19p
330	25	22p
330	63	38p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2200	16	40p
2200	25	63p
2200	40	70p
2200	63	134p
4700	16	75p
4700	35	120p

Beautiful Mini Radial Low Voltage

Matsushita only

uFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p

Cermet 20 Turn Precision Presets

50Ω, 100Ω,
200Ω, 500Ω
1K, 2K, 5K,
10K 20K,
50K, 100K
250K, 500K

99p eac'

1000vdc Caps (300VAC) Axial

1nF, 2 2nF	23p
4 7nF, 6 8nF	26p
10nF	28p
22nF, 33nF	37p
47nF	45p
100nF	48p
220nF	74p
470nF	1.10

1500VDC Caps (300VAC) Axial

1nF, 2 2nF	30p
3 3nF, 4 7nF	32p

2000VDC Axial

100nF 20% 76p

Ceramic Hi Volt Disc Capacitors

100p/1KV	20p
100p/2KV	24p
100p/3KV	26p
100p/4KV	28p
220p/6KV	30p
470p/2KV	27p
470p/6KV	32p
1n/2KV	28p
1n/6KV	32p
2n2/2KV	30p
2n2/4KV	32p
2n2/5KV	33p
3n3/2KV	31p
3n3/4KV	32p
4n7/4KV	33p

400V Polyester Capacitors

1nF, 1 5nF, 2 2nF	18p
3 3nF, 4 7nF, 6 8nF	19p
10nF, 15nF, 22nF	20p
33nF, 47nF, 68nF	22p
100nF, 150nF	25p
220nF	38p
330nF	58p
470nF	66p

ETCH RESIST TRANSFERS

1. Thin lines
2. Thick lines
3. Thin bends
4. Thick bends
5. DIL pads
6. Transistor pads
7. Dots + holes
8. 0.1" edge cons.
9. Mixture

any sheet of above 30 p

Set of 13 sheets 3.00

Wire & Cable

Prices per metre

Solid Hook up Wire

Any colour 5p

Mains/Speaker Cable (per metre)

Twin 1 amp	14p
Twin 2½ amp	16p
3 Core 2½ amp	18p
3 Core 6 amp	31p
3 Core 13 amp	56p

Solid Multicore

4 Core	33p
8 Core	39p
12 Core	46p
50 Core	1.37

Screened Cable

Single	14p
Stereo	27p
Mini Single	12p
Mini Stereo	15p
4 Core 4 Screens	44p
4 Core 1 Screen	54p
8 Core	61p
12 Core	80p

Aerial Cable

50Ω RG58A	36p
75Ω UHF	36p
75Ω VHF	28p
300Ω Flat	14p

Rainbow Ribbon Cable

10 Way	65p
24 Way	152p
40 Way	210p

PHOTO SENSITIVE PCB

1st Class Epoxy Glass. For better results than spraying. Expose to UV

Single sided

100 × 160	1.55
100 × 220	1.90
203 × 114	1.85
233 × 220	3.99

Double sided

100 × 160	1.65
100 × 220	2.15
203 × 114	2.21
233 × 220	4.55

Developer for above (do not use Sodium Hydroxide) 500 ml 2.50

DALO ETCH RESIST PEN

+ spare nib 90p

ANTEX SOLDERING IRONS

C240 (15W)	4.59
X25 (25W)	4.99
Iron stand	1.65
C240 Element	1.99
X25 Element	2.05

Bits C240

No 2 (Small)	65p
No 3 (Med)	65p
No 6 (Micro)	65p

Bits X25

No 50 (Small)	65p
No 51 (Med)	65p
No 52 (Lge)	65p

SOLDER

125gms

18 swg	2.95
22 swg	3.10

DIL SOCKETS

Pins	Lo-prof	W Wp.
8	8 p	25 p
14	9 p	35 p
16	10 p	40 p
18	16 p	50 p
20	20 p	–
22	22 p	–
24	24 p	70 p
28	28 p	79 p
40	30 p	99 p

TRANSISTORS

Probably the largest retail variety in UK If you don't see what you want please phone or write as this is not a full list

2N404	1.50
2N914	20p
2N916	39p
2N917	65p
2N918	33p
2N929	36p
2N929A	45p
2N930	20p
2N930A	30p
2N1131	24p
2N1132	25p
2N1302	45p
2N1303	65p
2N1304	60p
2N1306	65p
2N1308	65p
2N3170	58p
2N1420	66p
2N1483	2.95
2N1485	3.47
2N1507	42p
2N1524	58p
2N1702	3.20
2N1711	35p
2N1889	50p
2N1890	50p
2N1893	30p
2N1974	1.50
2N2060	7.14
2N2102	39p
2N2217	39p
2N2218	33p
2N2218A	25p
2N2219	27p
2N2219A	28p
2N2220	22p
2N2221	22p
2N2221A	23p
2N2222	24p
2N2222A	25p
2N2223	2.60
2N2223A	4.15
2N2303	39p
2N2368	25p
2N2369	19p
2N2369	18p
2N2405	88p
2N2410	1.15
2N2411	3.60
2N2412	80p
2N2477	95p
2N2483	25p
2N2484	26p
2N2491	8.00
2N2646	45p
2N2647	98p
2N2714	12p
2N2848	60p
2N2875	2.20
2N2890	1.10
2N2891	2.28
2N2892	3.00
2N2904A	27p
2N2905	28p
2N2905A	29p
2N2906	25p
2N2906A	30p
2N2907	25p
2N2907A	26p
2N2920	3.47
2N2923	25p
2N2924	15p
2N2925	15p
2N2926	10p
2N3010	75p
2N3011	25p
2N3019	50p
2N3053	27p
2N3054	56p

2N3055H	60p
2N3055	120p
2N3107	46p
2N4240	42p
2N3109	48p
2N3232	1.50
2N3250	36p
2N3251	36p
2N3300	60p
2N3301	68p
2N3302	80p
2N3390	38p
2N3391	30p
2N3391A	34p
2N3392	27p
2N3393	24p
2N3394	20p
2N3395	26p
2N3396	26p
2N3397	27p
2N3402	35p
2N3403	50p
2N3404	50p
2N3405	50p
2N3416	24p
2N3417	23p
2N3420	2.50
2N3439	98p
2N3440	80p
2N3441	1.25
2N3442	1.35
2N3442RCA	1.85
2N3444	1.70
2N3445	4.80
2N3446	6.09
2N3447	5.72
2N3448	6.56
2N3468	1.00
2N3512	1.06
2N3553	2.30
2N3563	20p
2N3564	25p
2N3565	20p
2N3566	50p
2N3567	55p
2N3568	50p
2N3569	50p
2N3570	2.54
2N3571	2.19
2N3572	2.06
2N3584	2.76
2N3585	2.99
2N3605	36p
2N3606	28p
2N3607	28p
2N3632	9.88
2N3638	35p
2N3638A	37p
2N3639	36p
2N3641	39p
2N3642	25p
2N3643	15p
2N3644	28p
2N3645	33p
2N3646	28p
2N3662	15p
2N3663	16p
2N3691	18p
2N3692	20p
2N3693	25p
2N3694	30p
2N3702	10p
2N3703	10p
2N3704	10p
2N3705	10p
2N3706	10p
2N3707	10p
2N3708	10p
2N3709	10p
2N3710	10p
2N3711	10p
2N3712	2.00
2N3713	1.38
2N3714	2.98
2N3715	3.31
2N3716	3.60
2N3724	75p
2N3725	85p
2N3730	4.65
2N3732	2.88
2N3734	1.30
2N3725	2.45
2N3738	2.00
2N3740	2.38
2N3741	2.76
2N3766	2.90
2N3767	3.19
2N3771	1.75
2N3772	1.83
2N3773	2.06
2N3779	1.70
2N3789	3.27
2N3790	2.73
2N3791	2.47
2N3792	2.68
2N3749	25p
2N3819	21p
2N3820	38p
2N3821	1.84
2N3822	90p
2N3823	45p
2N3824	1.70
2N3826	78p
2N3827	78p
2N3854	44p
2N3855	30p
2N3855A	40p
2N3856	45p
2N3858	31p
2N3858A	37p
2N3859A	31p
2N3860	31p
2N3866	90p
2N3877A	35p
2N3900	25p
2N3901	30p
2N3902	6.65
2N3903	15p
2N3904	15p
2N3905	15p
2N3906	15p
2N3945	85p
2N3962	30p
2N3964	1.42
2N4030	66p
2N4031	55p
2N4032	65p
2N4036	58p
2N4037	43p
2N4058	10p
2N4059	17p
2N4060	12p
2N4061	10p
2N4062	10p
2N4064	1.15
2N4069	1.00
2N4074	75p
2N4092	98p
2N4093	1.20
2N4121	45p
2N4122	45p
2N4123	21p
2N4124	35p
2N4125	37p
2N4126	27p
2N4220	75p
2N4221	95p
2N4222	97p
2N4223	97p
2N4224	98p
2N4234	45p
2N4236	45p

2N4237	1.21
2N4238	95p
2N4239	1.00
2N4240	3.00
2N4248	15p
2N4249	17p
2N4250	17p
2N4258	75p
2N4266	45p
2N4275	48p
2N4284	32p
2N4285	35p
2N4287	45p
2N4288	22p
2N4289	15p
2N4290	45p
2N4291	45p
2N4292	45p
2N4294	45p
2N4297	2.50
2N4302	39p
2N4303	40p
2N4304	41p
2N4314	60p
2N4342	68p
2N4347	2.26
2N4351	1.16
2N4400	15p
2N4401	27p
2N4402	30p
2N4403	30p
2N4409	36p
2N4410	42p
2N4427	79p
2N4440	12.58
2N4870	80p
2N4871	55p
2N4888	92p
2N4898	1.29
2N4901	1.69
2N4902	3.52
2N4903	3.24
2N4904	2.75
2N4905	3.25
2N4906	3.42
2N4907	3.20
2N4908	3.70
2N4909	2.90
2N4910	1.95
2N4913	2.59
2N4914	2.69
2N4915	2.95
2N4916	48p
2N4917	47p
2N4918	95p
2N4919	1.28
2N4920	1.34
2N4921	55p
2N4922	69p
2N4923	99p
2N4924	92p
2N4926	95p
2N4927	95p
2N4928	1.59
2N4964	27p
2N4965	25p
2N4966	25p
2N4967	25p
2N4968	25p
2N4969	31p
2N5010	8.50
2N5011	9.37
2N5030	44p
2N5033	48p
2N5036	1.60
2N5036	1.95
2N5039	3.90
2N5086	36p
2N5087	39p
2N5088	37p
2N5089	37p
2N5126	48p
2N5217	38p
2N5128	38p
2N5129	30p
2N5130	37p
2N5131	22p
2N5133	22p
2N5135	38p
2N5136	38p
2N5137	23p
2N5138	18p
2N5139	48p
2N5140	25p
2N5141	25p
2N5143	25p
2N5172	15p
2N5175	58p
2N5179	39p
2N5180	43p
2N5183	1.00
2N5184	1.10
2N5188	1.15
2N5189	1.00
2N5190	68p
2N5191	70p
2N5193	90p
2N5194	79p
2N5209	24p
2N5210	25p
2N5219	25p
2N5220	15p
2N5221	25p
2N5222	28p
2N5223	15p
2N5224	38p
2N5225	25p
2N5226	25p
2N5227	25p
2N5232	30p
2N5232A	32p
2N5245	37p
2N5246	40p
2N5247	45p
2N5248	46p
2N5249	48p
2N5266	2.88
2N5293	98p
2N5294	1.28
2N5295	1.37
2N5296	1.28
2N5298	1.37
2N5302	3.20
2N5303	3.80
2N5305	25p
2N5306	37p
2N5307	40p
2N5308	25p
2N5354	19p
2N5355	19p
2N5358	73p
2N5366	25p
2N5367	28p
2N5401	35p
2N5415	1.10
2N5416	1.54
2N5447	16p
2N5448	19p
2N5449	21p
2N5450	23p
2N5451	25p
2N5457	29p
2N5458	29p
2N5459	29p
2N5460	72p
2N5461	60p
2N5462	80p
2N5484	40p
2N5485	29p
2N5490	1.37
2N5492	1.56
2N5494	1.37
2N5496	1.59

2N5543	5.00
2N5551	37p
2N5640	45p
2N5654	35p
2N5786	80p
2N5813	23p
2N5884	7.28
2N6027	30p
2N6030	6.60
2N6082	11.99
2N6099	1.20
2N6101	1.30
2N6109	1.15
2N6111	1.00
2N6121	54p
2N6122	56p
2N6123	59p
2N6124	56p
2N6125	59p
2N6126	71p
2N6129	79p
2N6130	93p
2N6131	98p
2N6132	83p
2N6133	1.14
2N6134	1.36
2N6253	1.45
2N6254	1.55
2SC1306	95p
2SC2078	1.70
2SJ49	3.98
2SJ50	4.45
2SJ82	4.29
2SK134	3.98
2SK135	4.45
2SK226	4.29
3N139	3.30
3N140	2.37
3N143	2.85
3N152	3.00
3N153	2.47
3N154	2.56
3N200	6.93
3N201	2.98
40280	2.00
40290	2.00
40309	1.80
40311	97p
40312	1.64
40313	1.89
40315	1.94
40316	95p
40324	1.86
40325	2.46
40326	1.98
40346	1.30
40347	89p
40348	1.95
40360	60p
40361	67p
40362	67p
40363	2.22
40364	2.90
40372	1.80
40373	2.60
40374	2.84
40389	1.24
40390	2.72
40392	1.20
40394	1.10
40394	1.70
40406	1.39
40407	75p
40408	1.59
40410	1.80
40411	2.85
40412	90p
40422	2.95
40467A	1.29
40513	1.75
40537	96p
49543	1.60
40594	99p
40595	99p
40600	2.58
40601	2.36
40602	1.68
40603	1.09
40604	1.85
40608	2.44
40622	1.45
40625	1.60
40626	3.20
40631	1.90
40631	2.12
40635	1.35
40637	2.00
40643	1.80
40673	83p
40822	1.80
40871	89p
40872	89p
AC125	35p
AC126	25p
AC127	25p
AC128	25p
AC132	39p
AC151	51p
AC152	45p
AC153	55p
AC153K	64p
AC176	27p
AC176K	37p
AC187	25p
AC187K	28p
AC188	25p
AC188K	40p
ACY17	70p
ACY18	90p
ACY20	75p
ACY21	75p
ACY22	75p
ACY28	75p
ACY44	98p
AD136	7.90
AD145	1.65
AD149	79p
AD150	1.31
AD161	39p
AD162	39p
AF106	75p
AF109	75p
AF114	65p
AF117	70p
AF118	89p
AF124	72p
AF125	72p
AF126	72p
AF139	53p
AF170	88p
AF172	88p
AF178	88p
AF200	65p
AF201	75p
AF239	1.24
AF240	1.00
AF279B	75p
AF279G	75p
AL102	3.49
AU110	2.20
AU113	2.30
BC107	10p
BC107A	12p
BC107B	12p
BC108	10p
BC108A	12p
BC108B	12p
BC108C	14p
BC109	10p
BC109B	12p
BC109C	12p

BC113	30p
BC114	19p
BC115	22p
BC116	32p
BC116A	37p
BC117	19p
BC118	19p
BC119	38p
BC121	82p
BC123	82p
BC125	37p
BC132	39p
BC134	36p
BC135	45p
BC136	45p
BC137	39p
BC138	55p
BC140	29p
BC141	37p
BC142	29p
BC143	34p
BC147	10p
BC147A	10p
BC147B	10p
BC147C	20p
BC148	10p
BC148A	12p
BC148B	13p
BC148C	13p
BC149	10p
BC149B	12p
BC149C	13p
BC152	35p
BC153	23p
BC154	27p
BC157	11p
BC157A	12p
BC157B	13p
BC158	10p
BC158A	12p
BC158B	13p
BC159	11p
BC159A	12p
BC159B	13p
BC159C	18p
BC160	42p
BC161	48p
BC167	10p
BC167A	10p
BC167B	13p
BC168	10p
BC168B	10p
BC168C	10p
BC169	10p
BC169B	10p
BC169C	10p
BC170	15p
BC170A	17p
BC170B	17p
BC170C	18p
BC171	12p
BC171A	15p
BC171B	15p
BC172	12p
BC172A	15p
BC172B	15p
BC172C	16p
BC173	11p
BC173B	16p
BC173C	16p
BC174	21p
BC174A	24p
BC174B	24p
BC175	75p
BC177	16p
BC177A	25p
BC177B	26p
BC178	16p
BC178A	24p
BC178B	25p
BC179	20p
BC179A	25p
BC179B	25p
BC179C	27p
BC182	10p
BC182A	12p
BC182B	13p
BC182L	10p
BC182LA	13p
BC182LB	14p
BC183	10p
BC183A	11p
BC183B	12p
BC183C	13p
BC183L	10p
BC183LA	13p
BC183LB	13p
BC183LC	14p
BC184	10p
BC184B	12p
BC184C	13p
BC184L	10p
BC184LB	13p
BC184LC	14p
BC196	24p
BC187	24p
BC204	29p
BC205	29p
BC206	29p
BC207	29p
BC208	29p
BC209	29p
BC212	10p
BC212A	12p
BC212B	13p
BC212L	10p
BC212LA	13p
BC212LB	14p
BC213	10p
BC213A	11p
BC213B	12p
BC213C	13p
BC213L	10p
BC213LB	13p
BC213LC	14p
BC214	10p
BC214B	12p
BC214C	13p
BC214L	10p
BC214LB	13p
BC214LC	14p
BC237	14p
BC237A	16p
BC237B	17p
BC237C	18p
BC238	14p
BC238A	15p
BC238B	16p
BC238C	17p
BC239	15p
BC239A	16p
BC239B	17p
BC239C	18p
BC250	22p
BC250A	23p
BC250B	24p
BC250C	25p
BC251	25p
BC251A	26p
BC251B	27p
BC251C	28p
BC252	22p
BC252B	23p
BC252C	24p
BC253	22p
BC253B	23p
BC253C	24p
BC256	25p
BC256A	26p
BC256B	27p
BC257	26p
BC257A	27p
BC258	24p

BC258A	25p
BC258B	26p
BC259	25p
BC259B	26p
BC259C	27p
BC260	30p
BC260B	32p
BC260C	33p
BC261	33p
BC261A	34p
BC261B	35p
BC261C	36p
BC262	31p
BC262A	32p
BC262B	33p
BC262C	34p
BC263	30p
BC263B	31p
BC263C	32p
BC264	40p
BC264B	42p
BC266	35p
BC266A	36p
BC266B	37p
BC300	45p
BC301	44p
BC302	43p
BC303	47p
BC304	46p
BC307	13p
BC307A	14p
BC307B	15p
BC308	12p
BC308A	13p
BC308B	14p
BC309	14p
BC309A	15p
BC309B	16p
BC309C	17p
BC317	15p
BC318	15p
BC320	25p
BC321	25p
BC327	14p
BC328	14p
BC337	15p
BC338	15p
BC347	20p
BC350	20p
BC382	30p
BC382L	30p
BC383	30p
BC383L	30p
BC384	30p
BC384L	30p
BC407	30p
BC408	24p
BC409	30p
BC413	25p
BC414	25p
BC415	30p
BC416	30p
BC418	30p
BC440	32p
BC441	33p
BC460	32p
BC461	33p
BC478	29p
BC479	30p
BC516	40p
BC517	40p
BC547	13p
BC547A	14p
BC547B	14p
BC548	12p
BC548A	13p
BC548B	14p
BC548C	15p
BC549	13p
BC549B	14p
BC549C	15p
BC550	30p
BC550C	33p
BC557	15p
BC557A	16p
BC557B	16p
BC558	14p
BC558A	15p
BC558B	16p
BC559	15p
BC559B	16p
BC559C	17p
BC560	32p
BC560	32p
BC560C	34p
BC650	45p
BC651	46p
BCW32R	60p
BCY30A	1.30
BCY31	1.15
BCY31A	1.30
BCY32	1.15
BCY32A	1.30
BCY33	80p
BCY33A	1.00
BCY34	80p
BCY34A	80p
BCY54	1.91
BCY58	32p
BCY59	33p
BCY66	1.80
BCY67	2.00
BCY70	16p
BCY71	16p
BCY72	19p
BCY77	34p
BCY78	22p
BCY79	22p
BCY87	6.60
BCY88	4.90
BCY89	4.10
BCZ10	4.60
BCZ11	4.60
BD115	58p
BD116	2.50
BD121	2.25
BD124	1.50
BD131	44p
BD132	44p
BD135	40p
BD136	40p
BD137	42p
BD138	39p
BD139	39p
BD140	39p
BD142	2.40
BD153	1.25
BD155	1.20
BD157	54p
BD158	55p
BD160	3.80
BD181	1.75
BD182	2.50
BD183	2.70
BD187	1.09
BD201	1.30
BD202	1.39
BD204	1.44
BD220	1.00
BD221	95p
BD223	1.00
BD224	95p
BD232	1.11
BD233	70p
BD234	72p
BD237	98p
BD238	98p
BD239A	57p
BD239C	64p
BD240A	59p
BD240C	73p
BD241A	61p
BD241C	67p

BD242A	65p
BD242C	70p
BD243A	72p
BD143C	85p
BD244A	82p
BC244C	1.00
BD245A	1.14
BD245C	1.30
BD246A	1.20
BD246C	1.50
BC249A	2.00
BD249C	2.31
BD250A	2.11
BD250C	2.46
BD433	79p
BD434	55p
BD435	81p
BD436	81p
BD437	88p
BD438	88p
BD439	90p
BD440	91p
BD441	91p
BD442	93p
BD529	1.20
BD530	1.30
BD535	75p
BD536	75p
BD537	80p
BD538	80p
BD539	80p
BD539C	1.10
BD540	85p
BD540C	1.20
BD675	72p
BD676	77p
BD677	78p
BD678	83p
BD711	1.32
BD712	1.32
BDX14	1.30
BDX18	1.59
BDX32	3,47
BDY10	2.00
BDY11	2.50
BDY17	2.89
BDY23	3.40
BDY25	3.75
BDY38	1.74
BDY54	1.70
BDY55	1.75
BDY56	1.80
BDY57	5.25
BDY58	6.15
BDY60	1.60
BDY61	2.80
BDY62	2.34
BDY92	3.75
BF115	35p
BF119	1.00
BF121	75p
BF123	70p
BF127	80p
BF153	39p
BF154	25p
BF157	58p
BF158	25p
BF159	58p
BF160	55p
BF161	58p
BF163	50p
BF166	57p
BF167	29p
BF170	79p
BF173	25p
BF174	77p
BF177	25p
BF178	30p
BF179	35p
BF180	35p
BF181	36p
BF182	36p
BF183	38p
BF184	36p
BF185	37p
BF194	12p
BF195	12p
BF196	12p
BF197	12p
BF198	15p
BF199	15p
BF200	1.49
BF224J	32p
BF225J	35p
BF240	38p
BF241	38p
BF244A	35p
BF244B	39p
BF245A	
BF245B	51p
BF246	52p
BF246A	
BF246B	51p
BF247A	54p
BF247B	55p
BF254	39p
BF255	42p
BF256A	35p
BF256B	45p
BF256C	62p
BF257	30p
BF258	32p
BF259	35p
BF262	80p
BF263	90p
BF270	65p
BF271	68p
BF273	40p
BF274	40p
BF324	38p
BF336	36p
BF337	28p
BF338	48p
BF355	60p
BF362	85p
BF363	85p
BF457	46p
BF458	56p
BF459	62p
BF469	86p
BF470	86p
BFR39	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFR90	2.11
BFS28	2.95
BFS61	1.00
BFS98	1.10
BFT19	1.65
BFT19B	1.88
BFT66	2.48
BFW10	1.48
BFW10	1.48
BFW11	1.48
BFW43	2.47
BFW59	1.06
BFW87	1.53
BFW90	1.53
BFX12	1.00
BFX13	91p
BFX19	50p
BFX20	80p
BFX29	26p
BFX30	27p
BFX34	1.00
BFX37	70p
BFX43	70p
BFX68	1.00
BFX84	27p
BFX85	28p

BFX86	28p
BFX87	25p
BFX88	26p
BFX89	1.75
BFY18	48p
BFY19	1.10
BFY37	1.20
BFY39	50p
BFY41	1.16
BFY50	23p
BFY51	23p
BFY52	23p
BFY53	31p
BFY56	31p
BFY56A	68p
BFY75	75p
BFY76	50p
BFY77	80p
BFY78	80p
BFY90	79p
BSV81	1.87
BSW41	95p
BSW67	1.00
BSW70	1.00
BSX19	24p
BSX20	24p
BSX21	40p
BSX27	78p
BSX28	66p
BSX29	34p
BSX39	80p
BSX60	75p
BSX61	80p
BSX76	50p
BSX77	55p
BSY24	77p
BSY25	1.00
BSY26	35p
BSY29	70p
BSY39	47p
BSY54	40p
BSY65	58p
BSY95A	25p
BU104	2.22
BU105	1.70
BU109	3.29
BU126	1.47
BU204	2.25
BU205	1.75
BU206	1.89
BU208	1.98
BU326S	2.35
BU406	1.45
BU407	1.45
BU408	1.35
BU409	1.25
BU500	2.95
BUV20	11.00
BUV21	10.90
BUV23	13.60
BUV24	12.10
BUV25	15.00
BUX20	17.00
BUY18S	3.95
E430	5.60
J300	48p
J310	53p
MA8001	45p
MA8002	62p
MA8003	39p
MD7000	2.60
ME0401	25p
ME0402	30p
ME0404	25p
ME0411	35p
ME0412	35p
ME0413	35p
ME0414	48p
ME0461	45p
ME0462	45p
ME1001	45p
ME1002	45p
ME1075	45p
ME1100	45p
ME1120	48p
ME3002	25p
ME4001	45p
ME4002	45p
ME4003	45p
ME4101	25p
ME4101	25p
ME4103	25p
ME4104	25p
ME6001	25p
ME6002	25p
ME6003	25p
ME6101	29p
ME6102	28p
ME8001	47p
ME8002	62p
ME8003	50p
ME9001	56p
ME9002	56p
MFE3004	2.36
MJ400	2.98
MJ420	2.26
MJ430	2.98
MJ440	
MJ481	1.69
MJ491	1.72
MJ802	3.99
MJ900	2.90
MJ901	3.10
MJ1000	2.50
MJ1001	3.00
MJ1800	3.60
MJ2500	2.19
MJ2501	2.25
MJ2955	1.00
MJ3000	2.19
MJ3001	2.25
MJ3701	2.55
MJ4502	3.99
MJE340	53p
MJE370	97p
MJE371	99p
MJE520	92p
MJE521	94p
MJE1090	3.65
MJE1100	3.65
MJE2901	3.65
MJE2955	99p
MJE3055	69p
MP8111	1.00
MP8112	1.39
MP8121	1.35
MP8122	1.40
MP8123	1.16
MP8512	1.59
MPF102	39p
MPF103	29p
MPF104	29p
MPF105	29p
MPF112	59p
MPF121	1.69
MPS3638	27p
MPS3640	40p
MPS4356	60p
MPS6517	47p
MPS6518	47p
MPS6530	37p
MPS6560	32p
MPS6562	32p
MPSA05	23p
MPSA06	25p
MPSA10	28p
MPSA12	29p
MPSA13	48p
MPSA14	46p
MPSA16	30p
MPSA18	65p
MPSA20	48p

MPSA42	49p
MPSA43	49p
MPSA55	28p
MPSA56	30p
MPSA65	40p
MPSA66	47p
MPSA70	45p
MPSA92	39p
MPSA93	39p
MPSL01	42p
MPSL51	48p
MPSU01	84p
MPSU04	1.32
MPSU05	55p
MPSU06	56p
MPSU07	75p
MPSU51	88p
MPSU55	58p
MPSU56	59p
MPSU57	1.20
MRF421	poa
MRF453	poa
MRF454	poa
MRF475	7.55
MRF477	poa
MRF479	poa
MRF604	poa
NKT124	63p
NKT125	49p
NKT126	47p
NKT128	42p
NKT129	40p
NKT135	40p
NKT137	42p
NKT210	42p
NKT215	40p
NKT216	65p
NKT218	44p
NKT219	40p
NKT224	40p
NKT225	40p
NKT229	40p
NKT238	46p
NKT239	44p
NKT240	42p
NKT241	40p
NKT242	40p
NKT243	86p
NKT243	86p
NKT244	40p
NKT254	40p
NKT261	40p
NKT262	40p
NKT271	40p
NKT272	40p
NKT275	40p
NKT281	47p
NKT404	2.68
NKT405	2.80
NKT406	2.50
NKT453	2.40
NKT603F	56p
NKT613F	55p
NKT674F	55p
NKT677F	55p
NKT713	47p
NKT717	52p
NKT734	55p
NKT736	58p
NKT773	40p
NKT781	43p
NKT12329	50p
NKT12429	57p
NKT13329	50p
NKT13429	54p
NKT16229	59p
NKT20329	38p
OC20	2.30
OC22	2.00
OC23	2.00
OC25	2.50
OC28	1.70
OC29	2.35
OC35	2.35
OC41	80p
OC43	70p
OC44	82p
OC70	50p
OC71	50p
OC72	50p
OC82	50p
OC82D	70p
OC83	75p
P346A	58p
R2008B	2.14
R2010B	1.88
SC107	27p
SC108	27p
SC109	27p
TIP29A	32p
TIP29C	38p
TIP30A	35p
TIP30C	38p
TIP31A	38p
TIP31C	39p
TIP32A	38p
TIP32C	42p
TIP33A	65p
TIP33C	78p
TIP34A	74p
TIP34C	88p
TIP35A	1.09
TIP35C	1.28
TIP36A	1.29
TIP36C	1.39
TIP41A	49p
TIP41C	55p
TIP42A	55p
TIP42C	65p
TIP49	1.20
TIP50	1.40
TIP53	1.57
TIP54	1.59
TIP110	74p
TIP112	90p
TIP115	81p
TIP117	96p
TIP120	69p
TIP122	73p
TIP125	1.20
TIP127	1.27
TIP130	1.50
TIP132	1.60
TIP135	1.60
TIP137	1.80
TIP140	1.04
TIP142	1.04
TIP145	1.19
TIP147	1.19
TIP162	4.95
TIP2955	77p
TIP3055	70p
TIS37	62p
TIS43	40p
TIS45	66p
TIS46	66p
TIS47	49p
TIS48	65p
TIS49	66p
TIS50	60p
TIS51	65p
TIS52	70p
TIS53	97p
TIS54	85p
TIS55	66p
TIS58	92p

CRICKLEWOOD-STOCKING PARTS OTHER STORES CANNOT REACH!

Items not fully covered on this list include: **OPTO:** 7 seg LEDs, LCDs, bezelled LEDs, Lamps, Lampholders. **FUSES:** 20 mm, 1¼ inch, slow or quick blow, Fuseholders. **CONNECTORS:** DIL, DIN, Phono, 1 mm, 2 mm, 4 mm, Bulgin, USA, I.E.C. **KNOBS:** Plastic, Aluminium, Anodised, Collet, Pointer. **SWITCHES:** Toggle, Biased, Rocker, Rotary, Slide, DIL, Push. **METERS:** LCD, Analogue, Test and Panel **TOOLS:** Pliers, Cutters, Strippers, Trimmers, Cable Cutters. And much, much more . . . .
All in stock items (that's 95%) posted same day. OFFICIAL ORDERS FROM SCHOOLS, GOVT. DEPTS ETC. WELCOME. OVERSEAS ORDERS WELCOME (CWO + ADEQUATE POSTAGE) QUANTITY DISCOUNTS BY NEGOTIATION.
CRICKLEWOOD ELECTRONICS LTD, 40 Cricklewood Broadway, London NW2 3ET, Tel: 01 452 0161, Telex: 914977

★ **THE LAZY WAY** Phone your order through on Access, Barclaycard, Visa or American Express for immediate service; no extra charge, no minimum order.
★ **THE TRADITIONAL WAY** Send cheque, PO or credit card number. Cash not encouraged but accepted (no coins please). All in stock items shipped same day.
★ **THE IDEAL WAY** Call in and collect. We are on the main Edgware Rd (A5) just 1½ miles from Staples Corner and approx 3 miles from Marble Arch.
VAT Please add VAT at the current rate to all orders except books. VAT not chargeable abroad
POST, PACKING & INSURANCE Standard small order charge is 70p (more for heavier goods). Export orders minimum £1.50.

TIS60	42p
TIS62	44p
TIS64	67p
TIS87	60p
TIS88A	62p
TIS90	28p
TIS91	30p
TIS92	30p
TIS93	54p
VN10KM	60p
VN46AF	84p
VN66AF	85p
ZTX107	10p
ZTX108	10p
ZTX109	10p
ZTX300	13p
ZTX301	15p
ZTX302	15p
ZTX303	23p
ZTX304	15p
ZTX310	35p
ZTX311	32p
ZTX312	35p
ZTX313	36p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX500	14p
ZTX501	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	34p
ZTX530	24p
ZTX531	25p
ZTX650	45p

DIACS

BR100	40p
ST2	25p

THYRISTORS
Sensitive Gate
Small Signal

2N5060	30p
2N5061	32p
2N5062	35p
2N5063	37p
2N5064	40p
BR101	75p
BRY39	60p
BRY55-100	60p
BRY55-300	67p
BRY56	50p
TIC44	35p
TIC47	50p

4, 8 & 12 Amps
Texas TO220
Suffix A - 100V
B - 200V
C - 300V
D - 400V
M = 600V

	TIC106A	46p
	TIC106B	47p
4A	TIC106C	48p
	TIC106D	59p
	TIC106M	68p
	TIC116A	66p
	TIC116B	68p
8A	TIC116C	71p
	TIC116D	73p
	TIC116M	80p
	TIC126A	72p
12A	TIC126B	72p
	TIC126C	73p
	TIC126D	77p
	TIC126M	95p

SIEMENS THYRISTORS

1 2 amp plastic	
Bst B0106 (100V)	60p
Bst B0113 (200V)	70p
Bst B0146 (700V)	1.12
4.7 amp plastic	
Bst B0206 (100V)	80p
Bst B0213 (200V)	1.10
Bst B0246 (700V)	2 00

TV Thyristors

2N4444	1.80
BT101-500R	1.40
BT106	1.50
BT116 Use TIC116M	
BT119	1.70
BT120	1.50
BT121	1.30
BT139/600	2.50

TRIACS
Texas 400V
TO220 Case

TIC206D(4A)	66p
TIC225D(6A)	74p
TIC226D(8A)	88p
TIC236D(12A)	1 16
TIC246D(16A)	1.22
TIC253D(20A)	1.90
TIC263D(25A)	2.11

Other Triacs

2N5756 (TO5)	1.44
2N6155 (TO127)	3.39
40432 (Quadrac)	2.23
40486 (TO5)	1.65
40512	2.70
40576 (TO66)	3.33
40842	1.92

DIODES

1N34A	30p
1N821	70p
1N823	92p
1N914	4p
1N916	6p
1N1190	1.47
1N1192	1.75
1N1194	1.65
1N1194A	1.80
1N1196A	2.41
1N1198A	2.65
1N1201A	97p
1N1204A	1.00
1N1206	1.20
1N3063	36p
1N3065	48p
1N3492	1.85

1N3493	2.20
1N3493R	2.20
1N3602	36p
1N3604	45p
1N3766	3.00
1N3768	4.50
1N3768R	4.50
1N4001	4p
1N4002	4½p
1N4003	5p
1N4004	5½p
1N4005	6p
1N4006	6½p
1N4007	7p
1N4009	20p
1N4148	6p
1N4150	18p
1N4448	22p
1N4517	22p
1N5172	30p
1N5176	94p
1N5400	12p
1N5401	13p
1N5492	14p
1N5403	15p
1N5404	16p
1N5405	17p
1N5406	18p
1N5407	19p
1N5408	20p
1N5024	52p
1N5625	60p
1N5626	62p
1N5627	68p
1S44	10p
1S131	40p
1S134	56p
1S421	1.00
1S421R	1.00
1S940	10p
1S941	11p
1S961	22p
AA119	28p
AA129	57p
AA144	25p
AAY30	44p
AAY33	46p
AAZ17	27p
BA100	22p
BA102	25p
BA115	25p
BA133	40p
BA138	30p
BA142	20p
BA144	15p
BA155	15p
BA156	38p
BA182	40p
BA201	18p
BA202	26p
BA316	25p
BA317	25p
BA318	30p
BAV10	16p
BAV19	15p
BAV20	15p
BAV49	15p
BAX13	10p
BAX16	11p
BAY38	20p
BAY44	15p
BAY93	10p
BB103B	70p
BB103G	70p
BB104B	80p
BB104G	80p
BB105	52p
BB105A	57p
BB105B	58p
BB109G	65p
BY126	20p
BY127	22p
BY134	52p
BY182	1.26
BY188A	65p
BY206	36p
BY207	36p
BY223	1.56
BY297	48p
BY299	55p
BYW11-800	1.40
BYW11-1000	2.00
BYW12-100	1 30
BYW12-200	1.40
BYW12-400	2.00
BYX10	36p
BYX50-200R	2.00
BYX55-350	62p
BYX71-350	1.10
BYX71-600	1.52
ITT33	15p
ITT44	10p
ITT921	10p
ITT923	15p
ITT2002	27p
MZ2361	1.80
OA10	70p
OA47	20p
OA90	10p
OA91	10p
OA95	20p
OA200	20p
OA202	20p
RAS508AF	75p
SPD9000	75p
SPD9002	95p

2 amp type
Square with hole

S01 (100)	37p
S02 (200)	40p
S04 (400)	40p
S08 (800)	55p

BRIDGE RECTIFIERS
(PIV shown in brackets)
1 amp type

W01 (100)	20p
W02 (200)	26p
W04 (400)	28p
W08 (800)	40p

6 amp type
Square with hole

PW01 (100)	50p
PW02 (200)	78p
PW04 (400)	85p
PW06 (600)	90p

25 amp type
Metal clad with hole

K01 (100)	2.20
K02 (200)	2.30
K04 (400)	2.80
K06 (600)	3.40

Proprietory Bridges

B40C1500	1.20
B80C3700	1.80
BY164	55p
BY179	92p

ZENER DIODES
400-500 mW
E24 Series
2 4-47 V 8p

1.3 Watt
E24 Series
3.3-82 V 15p

2 5 Watt
E24 Series
7.5 75V 1.10

5W wire ended following voltages only 3V3, 3V6, 4V3, 4V7, 5V6, 7V5, 8V2, 8V7, 9V1, 10V, 12V, 20V, 33V, 51V, 62V, 68V 1.25

10W Pos. Stud
Following voltages only 7V5, 13, 18, 20, 24, 27, 30, 33, 68, 82, 91, 100, 110 1.25

20W Pos Stud
(BZY93 series)
E24 values
7V5-75V 2 00

OPTO ELECTRONICS

2N5777	78p
2N5778	88p
2N5779	1.09
4N25	1.10
BP100	1.40
BP104	1.00
BPX25	2 47
BPX29	2 47
BPX48	6 76
BPX60	4 75
BPX61	3.48
BPX63	2.93
BPX79	4.60
BPX86	4 15
CQX13	40p
CQX23	53p
CQX33	48p
LD30A	15p
LD36A	18p
LD37A	18p
LD52A	12p
LD56A	15p
LD57A	15p
LD52C	30p
LD56C	30p
LD57C	30p
LD80A	18p
LD86A	22p
LD87A	22p
LD242	75p
LD271	40p
LD461	25p
LD466	1.45
LD468	1.65
LD471	27p
LD476	1 20
LD478	1.45
LD479	1.65
LD481	27p
LD486	1.25
LD488	1 70
LD489	1 89
LD599	81p
ORP12	1.20
RPY60	2 65
RPY63	2.65
TIL32	71p
TIL63	1 95
TIL64	1 95
TIL65	2 25
TIL66	2 30
TIL67	2 35
TIL78	60p
TIL81	1 60
TIL99	1 35
TIL116	1 10
TIL138	2 40
TIL139	2 40
TIL209	15p
TIL211	19p
TIL212	19p
TIL224	32p
TIL228	42p
TIL312	1.65
TIL313	1 65
TIL401	3 50
TIL403	3.80
TIL406	4 10

NEW OPTO DEVICES
inc. Superbright see next column.

POWERFET AMP MODULES FROM PANTECHNIC
now available from LONDON.
Send s.a.e. for specs.

PFA 100	16.00
PFA 200	22.55
10,000 mF 80 V	4.10

D. CONNECTORS 25 WAY

Solder type	
Male	1.60
Fmale	2.05
Angled PCB	
Male	2.45
Fmale	2.90
Covers	99p

NEW OPTO DEVICES
New LEDs
Now in stock
R = red
G = green
Y = yellow
Large diffused

	1+	50+
R5D	9p	7p
G5D	15p	12p
Y5D	15p	12p

Small diffused

R2D	8p	6p
G2D	12p	10p
Y2D	12p	10p
Micro 0 1"		
R1D	25p	22p
G1D	27p	25p
Y1D	27p	25p

Large clear

R5C	12p	10p
G5C	17p	13p
Y5C	17p	13p
Super bright Large (100 times brighter)		
R5U	38p	29p
G5U	42p	34p
Y5U	42p	34p
Tri-colour flat		
RGY8	83p	78p

LINEAR ICs

AY3-0215	7.95
AY1-5050	95p
AY1-5050	95p
AY1-1270	7.26
AY3-8910	5.39
AY3 8912	5.59
AY5-2376	5.89
CA3000	4.80
CA3001	4.95
CA3002	4.60
CA3005	3.15
CA3007	4.92
CA3010	1.30
CA3012	1.75
CA3013	4.12
CA3014	2.35
CA3015	2.62
CA3018	75p
CA3018A	2.00
CA3020	2.00
CA3020A	3.90
CA3021	3.20
CA3022	3.12
CA3026	1.52
CA2028A	1.21
CA3028B	2.53
CA3029	1.44
CA3030A	2.97
CA3033	5.44
CA3034	5.18
CA3036	2.75
CA3039	1.50
CA3041	3.47
CA3042	3.47
CA3043	3.92
CA3046	69p
CA3047	4.60
CA3048	2.99
CA3049	3.21
CA3050	4 11
CA3051	3.80
CA3052	2.92
CA3053	1.00
CA3054	1.66
CA3059	2.80
CA3060	4.09
CA3062	13.84
CA3065E	4.62
CA3068	4.23
CA3070	3 20
CA3071	3 30
CA3075	2.25
CA3076	3.42
CA3078T	2.25
CA3080	1.89
CA3080A	3.95
CA3080E	70p
CA3081	1.90
CA3085	1.35
CA3086	55p
CA3089E	1.95
CA3090AQ	3.70
CA3130E	87p
CA3130T	1.80
CA3140E	39p
CA3140T	85p
HA1366W	2.40
HA1388	2.54
ICL7106	7.40
ICL7107	9.50
ICL8038	2.99
ICM7555	80p
LC7120	3 20
LC7130	3.20
LC7137	4.00
LF347	1.50
LF351	47p
LF353	92p
LF355	83p
LF356	92p
LF357	1.09
LF13201	2.99
LF13331	3.30
LF13741H	68p
LF13741N	59p
LM10CH	4.25
LM11CH	4.50
LM114	6.75
LM137K	11.52
LM301AH	1.00
LM301AN	25p
LM305AH	2.90
LM305H	88p
LM307H	1.05
LM307N	55p
LM308AH	3.15
LM308AN	2.14
LM308H	95p
LM308N	88p
LM309K	2.80
LM310H	1.95
LM310N	1.89
LM311H	1.04
LM311N	70p
LM317K	2.80
LM317MP	1.04
LM318H	2.40
LM318N	1.49
LM319H	2.48
LM319N	2.10
LM320 – See 79XX Series Volt Regulators	
LM324N	29p
LM337K	4.75
LM337MP	1.65
LM337T	1.99
LM339AN	1.60
LM339N	47p
LM340 – See 78XX Series Volt Regulators	
LM345K	3.60
LM348N	62p
LM349N	1.16
LM350K	4.60
LM359N	1.44
LM360N	3.88
LM376N	65p
LM377N	1.69
LM378N	3.40
LM379S	4.79
LM380N14	75p
LM380N8	1.50

LM381AN	2.26
LM381N	1.40
LM382N	1.12
LM383T	3.40
LM384N	1.40
LM386N1	88p
LM386N4	1.20
LM388N	2.43
LM391N60	1.70
LM391N80	1.93
LM392N	76p
LM393N	96p
LM394H	3.80
LM396K	13.52
LM709N8	64p
LM709CH	1.00
LM710CH	89p
LM710CN	52p
LM711CH	1.38
LM711CN	70p
LM723CH	1.21
LM723CN	40p
LM725CH	3.40
LM725CN	3 19
LM733CN	69p
LM741CH	96p
LM741CN	15p
LM741CN14	80p
LM747CN	69p
LM748CH	1.00
LM748CN	35p
LM1303N	1.20
LM1304N	2.50
LM1305N	3.10
LM1307N	2.75
LM1310N	1.45
LM1330N	2.25
LM1458	44p
LM1496	1.08
LM1800	3.24
LM1801	2.99
LM1812	8.00
LM1818	2.99
LM1820	2.15
LM1828	4.79
LM1830	2.44
LM1845	4.12
LM1848	2.89
LM1850	2.75
LM1871	4.39
LM1872	4.39
LM1886	7.44
LM1889	3.77
LM2907N	2.75
LM2907NB	2.60
LM2917N	1.89
LM2917N8	1.89
LM3524	6.77
LM3301	1.60
LM3302	74p
LM3401	65p
LM3404	75p
LM3405	1.45
LM3900	48p
LM3905	1.25
LM3909	79p
LM3911	1.20
LM3914	1.79
LM3915	1.99
LM3916	2.19
LM4250CH	2.63
LM4250N	2.39
LM13600	1.09
MB3712	1.99
MB3756	3.80
MB8719	7.95
M53200	8.54
MC1303 = LM1303N	
MC1304 = LM1304N	
MC1305 = LM1305N	
MC1307 = LM1307N	
MC1310 LM13010N	
MC1330 = LM1330N	
MC1352	1.75
MC1456	1.80
MC1458 LM1458	
MC1466L	6.77
MC1495L	3.75
MC1496 = LM1496	
MC3340	1.45
MC3401 LM3401	
MC3403 LM3403	
MC3405 LM3405	
NE531N	1.36
NE543N	2.50
NE544N	1.80
NE555	16p
NE556	45p
NE558	1.89
NE560	3.25
NE562	4.09
NE565	1.18
NE566	1.49
NE567	1.37
NE570	3.75
NE571	3.75
NE5534	1.49
PLL02A	4.95
PLL03A	12.75
RC4136	59p
S556B	2.59
SAD1024A	8.49
SAS560	2.59
SAS570	2.59
SAS580	2.59
SAS590	2.59
SFF96364	7.99
SL610C	4.00
SL611C	4.00
SL612C	4.00
SL620C	6.00
SL621C	6.00
SL623C	10.00
SL630C	6.00
SL640C	6.00
SL641C	6.00
SN76001N	2.80
SN76008	3.90
SN76018	3.90
SN76003N	2.95
SN76013N	2.95
SN7023N = SN76033N	
SN76033N	2.95
SN76110	2.25
SN76115	2.65
SN76116	2.75
SN76226	3.45
SN76228	2.90
SN76477	4.49
SN76530	1.80
SN76550	80p
SN76666	2.90
SO41P	1.60
SO42P	1.60
TA7210	1.49
TA7204	1.95
TA7205	89p

TA7222	1.45
TA7310	1.49
TAA263	1.50
TAA300	3.95
TAA320	2.05
TAA350	3.60
TAA521	1.50
TAA522	2.47
TAA550	73p
TAA560	2.35
TAA570	2.35
TAA621AX1	2.75
TAA661A	1.50
TAA661B	1.70
TAA700	2.60
TAA930	2.50
TAA930B	2.63
TAA970	2.45
TAA991D	2.45
TAD100	2.00
TBA120AS	69p
TBA331	1.50
TBA341	2.05
TBA395	1.65
TBA396	1.50
TBA450	1.95
TBA460	1.53
TBA500	2.97
TBA500Q	3.11
TBA510	2.95
TBA510Q	3.05
TBA520	2.57
TBA520Q	2.75
TBA530	2.55
TBA530Q	2.76
TBA540	2.72
TBA540Q	2.74
TBA550	3.25
TBA550Q	3.27
TBA560C	2.87
TBA570	2.37
TBA570Q	2.48
TBA581	3.11
TBA641	3.00
TBA651	1.90
TBA673	4.15
TBA700	2.38
TBA700Q	2.47
TBA720AQ	2.60
TBA750	2.25
TBA750Q	2.46
TBA790A	2.11
TBA800	78p
TBA810	95p
TBA820	75p
TBA820M	75p
TBA920	1.95
TBA920Q	1.97
TBA950	2.25
TBA990	2.65
TBA990Q	2.74
TCA105	3.00
TCA160C	2.67
TCA220	3.44
TCA270	2.44
TCA440	2.20
TCA450	2.65
TCA640	4.15
TCA650	4.15
TCA660B	4.15
TCA730	4.80
TCA740	4.80
TCA750	4.85
TCA760	2.75
TCA800	3.50
TBA800Q	3.60
TCA830S	1.90
TCA910	2.19
TCA940	1.69
TDA1002	3.39
TDA1003	3.94
TDA1004	3.94
TDA1005	3.94
TDA1010A	1.79
TDA1022	4.95
TDA1024	1.19
TDA1034	3.20
TDA2020	2.99
TDA2030	2.85
TDA2522	4.20
TDA2530	3.30
TDA2540	4.10
TDA2541	4.10
TDA2560	4.10
TDA2571	4.40
TDA2581	3.75
TDA2590	5.20
TDA2591	4.73
TDA2600	6.15
TDA2610	3.90
TDA2611A	2.50
TDA2640	3.64
TDA3000	2.76
TL061	40p
TL062	60p
TL064	99p
TL071	36p
TL072	50p
TL074	1.30
TL081	50p
TL082	75p
TL083	85p
TL084	89p
TL170	49p
TL430	69p
UAA170	1.69
UAA180	1.69
ULN2003	85p
UPC575C2	2.65
UPC1156	2.75
XR2206	2.92
ZN414	79p
ZN419	2.25
ZN1034	1.99
ZN1040	6.69
ZTK22	89p
ZTK33	89p

TTL

7400	10½p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	20p
7407	20p
7408	14p
7409	14p
7410	14p
7411	16p
7412	18p
7413	18p
7414	25p
7416	20p
7417	20p
7420	15p
7421	20p
7422	20p
7423	20p
7425	24p
7426	28p
7427	22p
7428	26p
7430	14p
7432	22p
7433	22p
7437	25p
7438	25p
7440	15p
7441	65p
7442	32p
7443	90p
7444	90p
7445	50p
7446	60p
7447	40p
7448	44p
7450	15p
7451	15p
7453	15p
7454	14p
7460	15p
7470	34p
7472	25p
7473	25p
7474	20p
7475	25p
7476	28p
7480	49p
7481	1.19
7482	68p
7483	38p
7484	69p
7485	60p
7486	20p
7489	2.20
7490	20p
7491	35p
7492	25p
7493	25p
7494	36p
7495	36p
7496	40p
7497	90p
74100	80p
74104	50p
74105	55p
74107	22p
74109	25p
74110	35p
74116	50p
74118	59p
74119	80p
74120	59p
74121	25p
74122	40p
74123	40p
74125	35p
74126	34p
74128	36p
74132	29p
74136	30p
74141	55p
74142	1.99
74143	2.48
74144	2.10
74145	50p
74147	89p
74148	70p
74150	49p
74151	40p
74153	40p
74154	49p
74155	40p
74156	40p
74157	30p
74159	75p
74160	60p
74161	48p
74162	48p
74163	48p
74164	48p
74165	48p
74166	48p
74170	1.25
74172	2.75
74173	60p
74174	59p
74175	49p
74176	39p
74177	45p
74178	79p
74180	40p
74181	1.15
74182	60p
74184	90p
74185	90p
74186	4.69
74188	2.50
74190	48p
74191	48p
74192	45p
74193	45p
74194	45p
74195	46p
74196	45p
74197	48p
74198	83p
74199	83p
74221	53p

74LS TTL

74LS00	11p
74LS01	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS10	12p
74LS11	12p
74LS12	12p
74LS13	19p
74LS14	30p
74LS15	12p
74LS20	12p
74LS21	12p
74LS22	12p
64LS27	12p
74LS28	14p
74LS30	12p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	15p
74LS40	13p
74LS42	28p
74LS47	35p
74LS51	14p
74LS54	14p
74LS55	14p
74LS73	18p
74LS74	18p
74LS75	20p
74LS76	20p
74LS78	18p
74LS80	1.20
74LS83	36p
74LS85	48p
74LS86	16p
74LS90	24p
74LS92	25p
74LS93	24p
74LS95	39p
74LS96	96p
74LS107	20p
74LS109	27p
74LS112	22p
74LS113	22p
74LS114	22p
74LS122	36p
74LS123	36p
74LS124	89p
74LS125	24p
74LS126	25p
74LS132	39p
74LS136	29p
74LS138	32p
74LS139	30p
74LS145	70p
74LS147	1.57
74LS148	75p
74LS151	39p
74LS153	39p
74LS154	79p
74LS155	29p
74LS156	36p
74LS157	27p
74LS158	29p
74LS160	35p
74LS161	35p
74LS162	35p
74LS163	35p
74LS164	40p
74LS165	59p
74LS168	84p
74LS169	85p
74LS170	70p
74LS173	55p
74LS174	45p
74LS175	39p
74LS181	99p
74LS183	1.79
74LS190	36p
74LS191	36p
74LS192	36p
74LS193	37p
74LS194	32p
74LS195	32p
74LS196	45p
74LS197	48p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	60p
74LS245	70p
74LS247	50p
74LS248	55p
74LS249	55p
74LS251	30p
74LS253	32p
74LS257	35p
74LS258	35p
74LS259	55p
74LS261	1.35
74LS266	18p
74LS273	60p
74LS275	2.25
74LS279	30p
74LS280	1.60
74LS283	40p
74LS289	4.70
74LS290	45p
74LS293	40p
74LS295	89p
74LS298	89p
74LS299	2.50
74LS323	1.76
74LS324	1.45
74LS325	2.96
74LS326	2.39
74LS327	2.39
74LS347	95p
74LS348	1.00
74LS352	79p
74LS353	79p
74LS362	7.25
74LS365	29p
74LS366	29p
74LS367	29p
74LS368	29p
74LS373	59p
74LS378	58p
74LS386	1.14
74LS390	46p
74LS393	42p
74LS395	89p
74LS396	1.90
74LS398	2.70
74LS399	1.59
74LS445	99p
74LS490	2.20
74LS540	77p
74LS541	99p
74LS640	1.60
74LS641	1.69
74LS643	2.25
74LS644	2.75
74LS669	1.20
74LS670	1.40
74LS673	5.50
74LS674	9.99
74LS688	1.19

74S TTL

74S00	30p
74S02	32p
74S04	32p
74S08	75p
74S20	60p
74S30	60p
74S32	70p
74S40	1.45
74S64	1.02
74S65	1.02
74S74	75p
74S85	2.99
74S86	1.75
74S112	90p
74S113	90p
74S124	2.95
74S132	1.09
74S133	60p
74S138	1.25
74S139	1.49
74S140	2.50
74S153	7.95
74S157	2.75
74S163	3.00
74S174	2.50
74S175	3.20
74S188	3.50
74S189	3.50
74S194	3.50
74S200	4.50
74S201	4.00
74S225	5.25
74S261	3.00
74S262	8.50
74S287	2.99
74S288	1.99
74S289	1.57
74S301	3.20
74S470	3.25
74S471	6.25
74S473	12.50
74S474	3.99
74S475	8.25
74S571	9.00
74S573	9.00

74H TTL

74H00	1.45
74H01	1.45
74H04	1.55
74H05	1.55
74H10	1.45
74H11	1.45
74H20	1.45
74H21	1.45
74H30	1.45
74H40	1.55
74H51	1.75
74H53	1.65
74H54	1.45
74H55	1.40
74H60	1.70
74H62	1.75

74L TTL

74L02	1.00
74L10	1.70
74L47	3.27
74L74	1.20
74L85	4.20
74L86	1.50
74L93	2.30
74L98	2.99

74 CMOS/TTL

74C00	27p
74C04	29p
74C10	28p
74C14	89p
74C20	29p
74C30	36p
74C42	96p
74C48	1.40
74C73	54p
74C76	57p
74C83	1.74
74C85	1.34
74C86	1.10
74C89	5.95
74C90	1.05
74C93	1.44
74C95	1.00
74C107	60p
74C151	2.55
74C154	4.95
74C157	2.20
74C160	1.54
74C161	1.15
74C162	1.16
74C163	65p
74C164	1.15
74C165	2.00
74C173	98p
74C174	65p
74C175	75p
74C192	89p
74C193	68p
74C194	89p
74C195	70p
74C200	10.00
74C221	1.20
74C901	1.91
74C902	71p
74C903	2.30
74C904	1.84
74C905	10.88
74C907	1.91
74C908	1.87
74C911	9.59
74C912	8.00
74C914	2.88
74C915	1.99
74C918	2.50
74C920D	8.50
74C922	4.50
74C923	5.00
74C925	6.00
74C926	6.58
74C928	6.00
74C929	5.20
74C930J	7.80
74C932	3.12

40 CMOS

4000	10p
4001	10p
4002	11p
4006	49p
4007	15p
4008	32p
4009	24p
4010	10p
4011	10p
4012	15p
4013	20p
4014	46p
4015	58p
4016	20p
4017	32p
4018	45p
4019	26p
4020	44p
4021	39p
4022	48p
4023	12p
4024	32p
4025	12p
4026	79p
4027	20p
4028	29p
4029	29p
4030	14p
4031	1.19
4032	80p
4033	1.20
4035	1.29
4035	59p
4036	2.49
4037	1.30
4038	99p
4039	2.80
4040	46p
4041	40p
4042	39p
4043	46p
4044	41p
4045	89p
4046	44p
4047	39p
4048	39p
4049	22p
4050	23p
4051	44p
4052	49p
4053	49p
4054	79p
4055	83p
4056	89p
4059	4.35
4060	42p
4063	79p
4066	22p
4067	2.49
4068	14p
4069	13p
4070	13p
4071	13p
4072	13p
4073	13p
4075	13p
4076	45p
4077	13p
4078	13p
4081	12p
4082	12p
4085	49p
4086	53p
4089	1.50
4093	20p
4094	69p
4095	66p
4096	90p
4097	2.88
4098	74p
4099	90p

For higher numbers in 40 Series, substitute 74C for 40 prefix, eg 40107 = 74C107

45 CMOS

4502	59p
4503	29p
4507	33p
4508	1:19
4510	35p
4511	48p
4512	39p
4514	1.17
4515	1.17
4516	59p
4518	39p
4519	29p
4520	48p
4521	99p
4526	59p
4527	59p
4528	46p
4532	69p
4534	4.29
4536	2.59
4538	65p
4539	99p
4543	56p
4553	2.25
4555	35p
4556	35p
4560	1.49
4566	1.49
4569	1.59
4584	39p
4585	79p

COMPUTER ICs
CPUs

1802	7.00
2650A	11.99
6502	3.24
6800	2.74
6802	2.69
6809	8.50
8035	3.49
8060	10.90
8080A	2.79
8085A	3.49
8900	57.75
9980	21 00
SCMP1	17.66
Z80A	3.50

MEMORIES

2101	4.00
2102AL2	1.35
2111-1	3.00
2114(200ns)	80p
2532	3.60
2564	11.95
2708	2.25
2716 (5v)	2.11
2764	9.75
4027	3.00
4044	7.00
4060	9.50
4116(200ns)	75p
4118-3	3.25
4164	4.50
5204	7.50
6116	4.40
6514	3.30
6810	1.15
7489	4.20
74189	4.00
74LS289	3.25
74LS188	2.25
74LS287	3.05
74LS288	2.25

ZERO INSERTION DIL SOCKETS

24pin	4.90
40pin	5.30

LOGIC ICs
including
COMPUTER SUPPORT

ADC0800	22.50
ADC0816	14.90
ADC0817	10.06
AY5-2376	5.90
ICM7555	80p
INS1671	20.00
INS1771	20.00
INS1792	30.00
MC1466L	6.50
MC1488	55p
MC1489	55p
MC4024	3.25
MC4044	3.25
MK50250	10.00
MK50398	6.95
MM5303	6.25
MM5307	12.75
MM5357	22.50
MM57105	14.00
MM57109	12.00
MM57160	9.00
MM57161	9.00
MM58174	11.80
RO2513LC	6.99
RO2513UC	7.50
SAA5000	3.00
SAA5010	7.10
SAA5012	7.10
SAA5020	5.50
SAA5030	9.00
SAA5040	15.00
SAA5041	15.00
SAA5050	8.50
SAA5052	8.50
TMS6011	3.65
ULB2003A	85p
8T26	1.35
8T28	1.35
8T95	1.35
8T97	1.35
81LS95	90p
81LS96	1.20
81LS97	90p
81LS98	1.20
6522	3.19
6532	6.95
6821	1.12
6845	10.00
6847	10.00
6850	1.35
6852	2.40
6875	4.85
8131	3.75
8154	9.42
8155	3.50
8212	1.10
8216	1.00
8223	1.80
8224	1.10
8226	2.50
8228	2.50
8238	5.75
8243	4.68
8250	8.65
8251	3.15
8253	7.95
8254	10.00
8255	2.48
8257	4.00
8259	4.00
8279	4.40
8304	4.50
8544	1.50
8601	1.20
8678CABN	19.50
8832	2.60
8833	2.35
9097	3.00
9099	3.00
9601	5.50
9062	2.50
Z80ACTC	2.65
Z80ADART	8.00
Z80ADMA	10.00
Z80APIO	2.80
ZN425E8	3.39
ZN426E8	3 39
ZN427E8	5.99
ZN428E8	4.05

VOLTAGE REGULATORS
(See also Linear ICs)
– Positive –

100 mA	
78L05A	30p
78L12A	30p
78L15A	30p
78L24A	30p
100 mA TO5	
78L05CH	80p
78L12CH	80p
78L15CH	80p
78L24CH	80p
500 mA TO202	
7805M	47p
7812M	47p
7815M	47p
7842M	47p
1 Amp TO220	
7805T	39p
7812T	39p
7815T	39p
7824T	39p
1.5 Amp TO03	
7805K	1.39
7812K	1.39
7815K	1.39
7824K	1.39

– Negative –

100 mA TO92	
79L05	59p
79L12	59p
79L15	59p
500 mA TO202	
7905M	55p
7912M	55p
7915M	55p
7924M	55p
1 Amp. TO220	
7905T	44p
7912T	44p
7915T	44p
7924T	44p
1.5 Amp. TO3	
7905K	1.99
7912K	1.99
7915K	1.99
7924K	1.99

– Variable –

L200 (2A Pos)	2.50
LM137K	12.00
LM309K	1.35
LM317K	3.42
LM317MP	95p
LM317T	1.75
LM337K	4.60
LM337MP	1.73
LM337T	1.75
LM345K	3.60
LM350K	4.50
LM396K	13.52

DESOLDERING PUMP
High Quality
High Suction
Aluminium
Anodised with Screw in Teflon Nose £4.45
Spare Nose 85p
1,000s SOLD
GREAT VALUE!

GRAPHIC PROCESSORS

EF9365	62.00
EF9366	62.00

HEATSINKS CLIP-ON

TO1 (AC128)	18p
TO5 (BFY51)	18p
TO18 (BC109)	18p
TO220 (TIP29)	36p

Many other sinks in stock including power sinks
Please phone

Rechargeable Batteries.
Guaranteed minimum 500 charges

HP2(1 2AH)	2.10
HP2(4AH)	4.75
HP7 (½AH)	99p
HP11(1.2AH)	2.29

Chargers
TYPE H:
Adjusted to 6 of any HP type Above £15.59
TYPE P:
PP3 £5.50
TYPE A:
HP7 (Up to 4 at a time) £5.85

QUARTZ CRYSTALS
Please enquire about types not listed

32 768KHz	99p
100KHz	2.49
200KHz	2.79
1 00MHz	2.89
1 008MHz	2.74
2 00MHz	2.24
2.097152MHz	3.50
3.2768MHz	1.50
4.00MHz	3.00
4.194394MHz	2.00
4.433619MHz	1.10
5.00MHz	1.75
6.00MHz	1.50
6.9375MHz	3.50
8.00MHz	1.75
10.00MHz	1.75
18.00MHz	1.99
20.00MHz	1.99
27.648MHz	2.60
48.00MHz	1.75
100.00MHz	5.50
5.5 MHz Ceramic filter	90p

VALVES

DY86/87/802	1.32
ECC82	1.22
ECC83	1.22
ECC84	1.22
EF86	1.80
EL34	2.89
EL84	2.50
KT66	10.75
KT88	12.50
PC900	1.76
PCC84	3.00
PCC85	3.40
PCC89	1.89
PCF86	2.30
PCF201	3.00
PCF801	2.67
PCF802	2.11
PCL82	1.80
PCL85	2.20
PCL86	2.10
PCL805	2.20
PD510	4.95
PFL200	2.99
PL504	2.11
PL508	2.36
PL509	4.75
PL802	4.17
PY88	1.62
PY500A	2.63
6L6	2.59

PLUGS & SOCKETS
UHF PL259 types
Low loss, superior quality 50Ω

Lino plug	45p
Reducer	16p
Round skt	40p
Sqr skt	49p

BNC 50Ω

Plug	1 10
Socket	1.00
Line skt	1.15

'KEYNECTOR'
Bare Wire Mains Safety Block
£7.95

RELAY (MINI)
4 pole 2 way
75Ω 6 12V
3 amp contacts
£2 80

CANNON TYPE AUDIO PLUGS
(3 PIN XLR)

Male	1.70
Female	1.65
Sockets (Chassis)	
Male	1.50
Female	2.35

JACK PLUGS
Huge Discount for quantity please phone

¼" Mono	20p
¼" Stereo	30p
¼" Metal Mono	30p
2½mm Mono	12p
2½mm Metal Mono	20p
3½mm Mono	12p
3½mm Stereo	36p
3½mm Metal Mono	20p

JACK SOCKETS
Chassis

¼" Mono	20p
¼" Stereo	25p
2½mm Mono	15p
3½mm Mono	15p
Line	
¼" Mono	20p
¼" Metal	30p
¼" Stereo	30p
¼" Stereo Metal	40p
3½mm Mono	15p
3½mm Mono Line	20p

BOOKS (no VAT)
(Post inc prices)

Towers Transistor Manual (Bible)	10 50
TTL Data	3 95
Data conversion	4 50
Volt Reg Data	3 95
Interface Data	3 95
Memory applic	4.95
Audio-Radio Hbk	4.50
Special function handbook	3 95

COAX (TV)
All Metal

Plug	25p
Socket	25p
Line Skt	40p

3½ DIGIT LCD MULTIMETER
2 amps AC DC
1KV (DC)
750V (AC)
Incredible at
£34 50
(SAE brings specs)

elektor book service

FORMANT

Complete constructional details of the Elektor Formant Synthesiser — comes with a FREE cassette of sounds that the Formant is capable of producing together with advice on how to achieve them.
Price — UK . . . . **£5.25** Overseas **£5.50**

SC/COMPUTER (1)

Describes how to build and operate your own microprocessor system — the first book of a series — further books will show how the system may be extended to meet various requirements.
Price — UK . . . . **£4.45** Overseas **£4.70**

SC/COMPUTER (2)

The second book in series. An updated version of the monitor program (Elbug II) is introduced together with a number of expansion possibilities. By adding the Elekterminal to the system described in Book 1 the microcomputer becomes even more versatile.
Price — UK . . . . **£4.75** Overseas **£5.00**

BOOK 75

A selection of some of the most interesting and popular construction projects that were originally published in Elektor issue 1 to 8.
Price — UK . . . . **£4.25** Overseas **£4.50**

TV GAMES COMPUTER

This book, provides a different — and, in many ways, easier — approach to microprocessors. The TV games computer is dedicated to one specific task, as the name suggests. This provides an almost unique opportunity to have fun while learning!
Price — UK . . . . **£5.50** Overseas **£5.75**

JUNIOR COMPUTER BOOK 1

For anyone wishing to become familiar with (micro)computers, this book gives the opportunity to build and program a personal computer at a very reasonable cost.
Price — UK . . . . **£5.00** Overseas **£5.25**

JUNIOR COMPUTER BOOK 2

Follows in a logical continuation of Book 1, and contains a detailed appraisal of the software. Three major programming tools, the monitor, an assembler and an editor, are discussed together with practical proposals for input and peripherals.
Price — UK . . . . **£5.25** Overseas **£5.50**

JUNIOR COMPUTER BOOK 3

The next, transforming the basic, single-board Junior Computer into a complete personal computer system.
Price — UK . . . . **£5.25** Overseas **£5.50**

BOOK 4 **£5.25/£5.50**

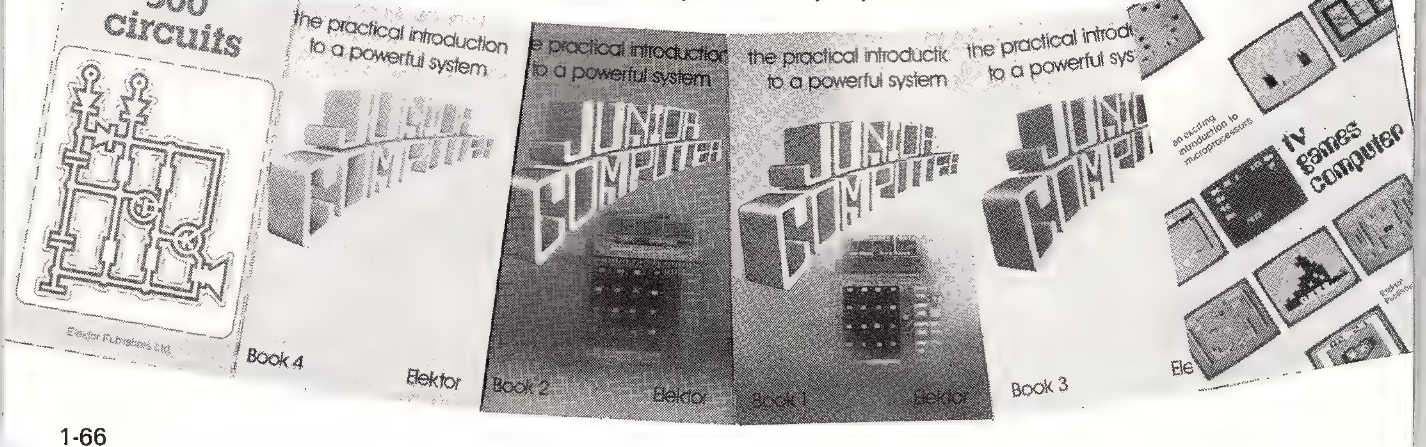
300 CIRCUITS

For the home constructor — 300 projects ranging from the basic to the very sophisticated.
Price — UK . . . . **£4.25** Overseas **£4.50**

DIGIBOOK

Provides a simple step-by-step introduction to the basic theory and application of digital electronics and gives clear explanations of the fundamentals of digital circuitry, backed up by experiments designed to reinforce this newly acquired knowledge. Supplied with an experimenter's PCB.
Price — UK . . . . **£5.50** Overseas **£5.75**

When ordering please use the Elektor Reader's Order Card in this issue (the above prices include p. & p.)



services to readers

EPS print service

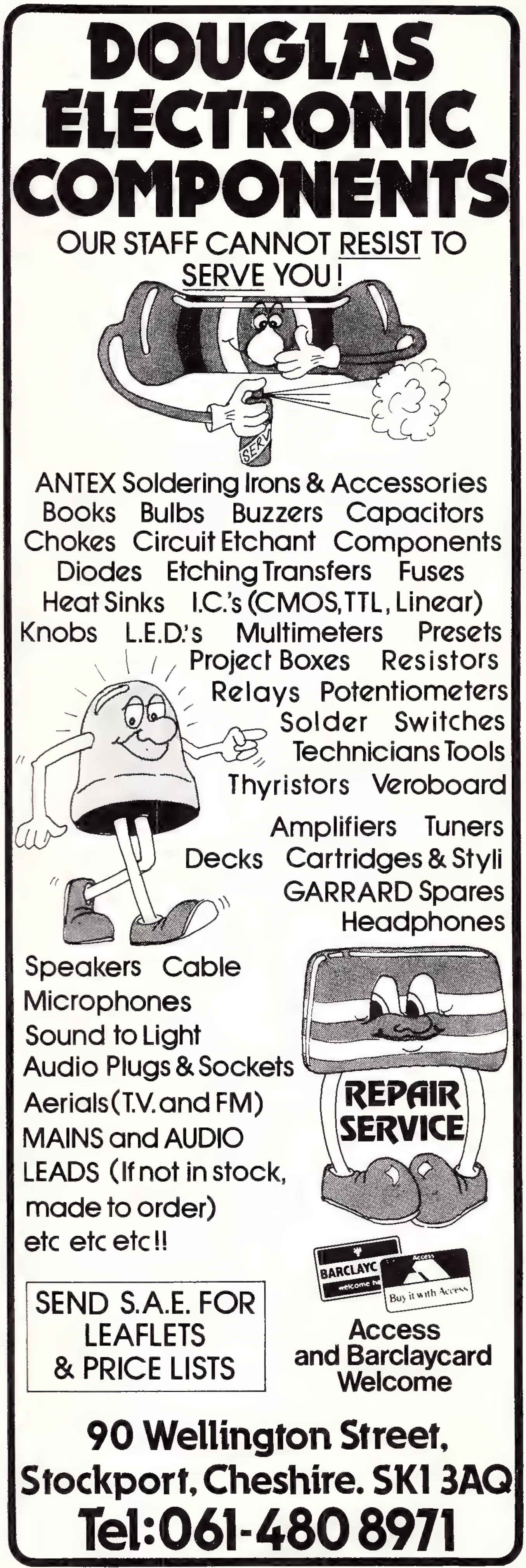
Many Elektor circuits are accompanied by printed circuit designs. Some of these designs, but not all, are also available as ready-etched and pre-drilled boards, which can be ordered from any of our offices. A complete list of the available boards is published under the heading 'EPS print service' in every issue. Delivery time is approximately three weeks.
It should be noted however that only boards which have at some time been published in the EPS list are available; the fact that a design for a board is published in a particular article does not necessarily imply that it can be supplied by Elektor.

Technical queries

Please enclose a stamped, self-addressed envelope; readers outside UK please enclose an IRC instead of stamps.
Letters should be addressed to the department concerned – TQE (Technical Queries). Although we feel that this is an essential service to readers, we regret that certain restrictions are necessary:

1. Questions that are not related to articles published in Elektor cannot be answered.
2. Questions concerning the connection of Elektor designs to other units (e.g. existing equipment) cannot normally be answered. An answer can only be based on a comparison of our design specifications with those of the other equipment.
3. Questions about suppliers for components are usually answered on the basis of advertisements, and readers can usually check these themselves.
4. As far as possible, answers will be on standard reply forms.

We trust that our readers will understand the reasons for these restrictions. On the one hand we feel that all technical queries should be answered as quickly and completely as possible; on the other hand this must not lead to overloading of our technical staff as this could lead to blown fuses and reduced quality in future issues.



DOUGLAS ELECTRONIC COMPONENTS

OUR STAFF CANNOT RESIST TO SERVE YOU!

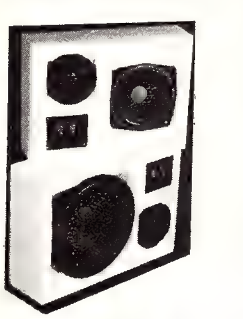
ANTEX Soldering Irons & Accessories
Books Bulbs Buzzers Capacitors
Chokes Circuit Etchant Components
Diodes Etching Transfers Fuses
Heat Sinks I.C.'s (CMOS, TTL, Linear)
Knobs L.E.D.'s Multimeters Presets
Project Boxes Resistors
Relays Potentiometers
Solder Switches
Technicians Tools
Thyristors Veroboard
Amplifiers Tuners
Decks Cartridges & Styli
GARRARD Spares
Headphones
Speakers Cable
Microphones
Sound to Light
Audio Plugs & Sockets
Aerials (T.V. and FM)
MAINS and AUDIO LEADS (If not in stock, made to order)
etc etc etc!!

REPAIR SERVICE

SEND S.A.E. FOR LEAFLETS & PRICE LISTS

Access and Barclaycard Welcome

90 Wellington Street,
Stockport, Cheshire. SK1 3AQ
Tel: 061-480 8971

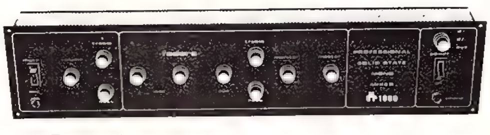


MULLARD SPEAKER KITS

A PURPOSELY DESIGNED 40 WATT R.M.S. 8 OHM SPEAKER SYSTEM RECENTLY DEVELOPED BY **MULLARD'S** SPECIALIST TEAM IN BELGIUM. Kit comprises a **Mullard 8"** Woofer with foam surround and aluminium voice coil. **Mullard** 3" high power dome tweeter. **B.K.E.** built and tested crossover, based on Mullard circuit combining low loss components, glass fibre board and recessed loudspeaker terminals. Recommended cabinet size 240 × 216 × 445 mm.
A superb sound at a relatively low cost. Complete with instructions. Price **£14.90 + £1.50 p&p per kit.**

New 5" 30 watt mini version of above now available.
Recommended cabinet size 180 × 155 × 295mm

Price **£13.90 + £1.00 p&p per kit.**



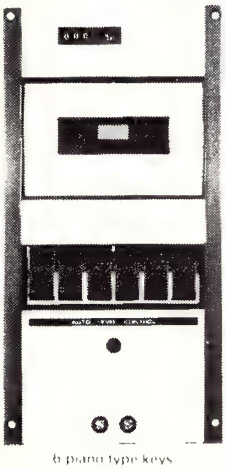
1000 MONO DISCO MIXER

A superb **fully built and tested** mixer/pre-amp with integral power supply. **4 Inputs** 2 turntables (ceramic cartridge). Aux. for tape deck etc., plus Mic. with override switch, all with individual level controls. Two sets of active tone controls (bass and treble) for Mic. and main inputs. Master volume control. Monitor output with select switch and volune control.

Outputs Main 750 mV Monitor 500 mW into 8 ohms. **Supply** 220/240V AC50/60Hz
Size 22½" × 4⅞" × 2½" **price £39.99 + £2.50 P&P**

BK ELECTRONICS

Prompt Deliveries
VAT inclusive
prices
Audio Equipment
Test Equipment
by
Thandar
and
Leader


6 piano type keys

STEREO CASSETTE TAPE DECK MODULE. Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
Features: Three digit tape counter. Auto-stop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity:** 100mV to 2V **Input Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K **Signal to noise ratio:** 45dB. **Wow and flutter:** 0.1%. **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided) **Dimensions:** Top panel 5½in x 11¼in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish
Price £26.70 + £2.50 postage and packing.
Supplementary parts for 18V D.C power supply (transformer, bridge rectifier and smoothing capacitor) **£3.50.**

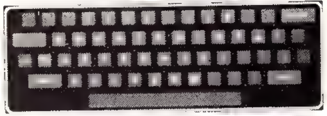
1K.WATT SLIDE DIMMER

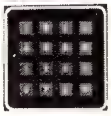
- Controls loads up to 1KW
- Compact size
  4¾" × 13/16" × 2½"
- Easy snap in fixing through panel/cabinet cut out
- Insulated plastic case
- Full wave control using 8amp triac
- Conforms to BS800
- Suitable for both resistance and inductive loads

Innumerable applications in industry, the home, and discos/theatres etc.

Price: **£11.70** each + **50p** P&P
(Any quantity)

KEYBOARDS





MEMBRANE KEYBOARDS manufactured from a tough polycarbonate film mounted on 1mm glass fibre printed circuit board assembly incorporating silver plated contacts.
16 way numeric keyboard Standard keyboard providing 0-9 and A-F functions.
Size: 100mm × 100mm Price: **£5.99 + 35p p&p**

Alpha Numeric Keyboard Full size 55 key non encoded keyboard with the commonly required functions in a Qwerty array. Matrix output via a 16 pin DIL socket.
Size: 350mm × 102mm Price: **£13.99 + 50p p&p**

BSR P256 TURNTABLE

P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti skate (bias device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut out template supplied ● Completely manual arm This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required
Price **£28.50** + £2 50 P&P

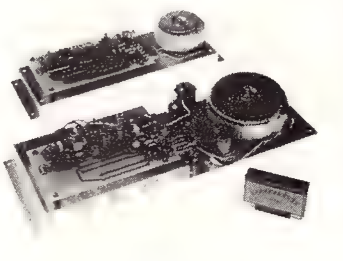
NEW RANGE QUALITY POWER LOUDSPEAKERS (15", 12" and 8"). These loudspeakers are ideal for both hi-fi and disco applications. Both the 12 and 15 units have heavy duty die-cast chassis and aluminium centre domes. All three units have white speaker cones and are fitted with attractive cast aluminium (ground finish) fixing escutcheons Specification and Price

15" 100 watt R.M.S. Impedance 8ohm 59 oz magnet, 2 aluminium voice coil Resonant Frequency 20Hz Frequency Response to 2 5KHz Sensitivity 97dB **Price £32 each** £3.00 Packing and Carriage each

12" 100 watt R.M.S. Impedance 8 ohm, 50 oz magnet. 2 aluminium voice coil Resonant Frequency 25Hz Frequency Response to 4KHz Sensitivity 95dB **Price £23.70 each.** £3.00 Packing and Carriage each.

8" 50 watt R.M.S. Impedance 8 ohms, 20 oz. 1½" aluminium voice coil, Resonant Frequency 40Hz, Frequency Response to 6KHz, Sensitivity 92dB Also available with black cone fitted with black metal protective grill. **Price: White cone £8.90 each. Black cone/grill £9.50 each.** P & P £1.25 each

POWER AMPLIFIER MODULES

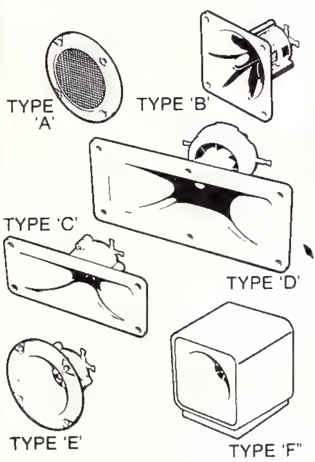


100 WATT R.M.S. AND 300 WATT R.M.S. MODULES
Power Amplifier Modules with integral toroidal transformer power supply, and heat sink. Supplied as one complete built and tested unit. Can be fitted in minutes. An LED Vu meter is available as an optional extra.

SPECIFICATION:
Max Output Power: 110 watts R.M.S. (OMP 100)
310 watts R.M.S. (OMP 300)
Loads: Open and short circuit proof. 4-16 ohms.
Frequency Response: 20Hz – 25KHz ±3dB.
Sensitivity for Max. Output:
500mV at 10K (OMP 100) 1V at 10K (OMP 300)
T.H.D.: Less than 0.1%
Supply: 240V 50Hz
Sizes: OMP 100 360 × 115 × 72mm
OMP 300 460 × 153 × 66mm
Prices: OMP 110 **£31.50 each + £2.00 P&P**
OMP 300 **£89.00 each + £3.00 P&P**
Vu Meter **£6.50 each + 50p P&P**

PIEZO ELECTRIC TWEETERS MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters As a crossover **is not** required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series) **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers **Price £3.45 each.**

TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A systems etc. **Price £4.35 each.**

TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc **Price £5.45 each.**

TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £6.90 each.**

TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £4.35 each.**

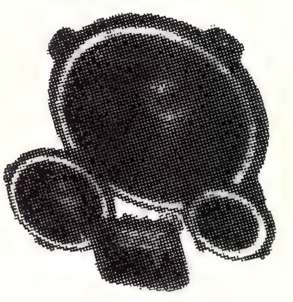
TYPE 'F' (KSN1057A) Cased version of type 'E' Free standing satellite tweeter. Perfect add on tweeter for conventional loudspeaker systems **Price £10.75 each.**
U.K. post free (or SAE for Piezo leaflets).

Matching 3-way loudspeakers and crossover

Build a quality 60watt RMS system 8ohms

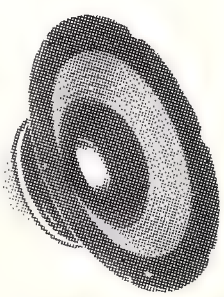
Build a quality 60 watt R.M S system

★ 10" Woofer 35Hz-4.5KHz
★ 3" Tweeter 2.5KHz-19KHz
★ 5" Mid Range 600Hz-8KHz
★ 3-way crossover 6dB/oct 1.3 and 6KHz
Recommended Cab-size 26" × 13" × 13"



Fitted with attractive cast aluminium fixing escutcheons and mesh protective grills which are removable enabling a unique choice of cabinet styling Can be mounted directly on to baffle with or without conventional speaker fabrics All three units have aluminium centre domes and rolled foam surround Crossover combines spring loaded loudspeaker terminals and recessed mounting panel
Price £22.00 per kit + £2 50 postage and packing Available separately, prices on request

12" 80 watt R.M.S. loudspeaker.
A superb general purpose **twin cone** loudspeaker 50 oz. magnet. 2 aluminium voice coil. Rolled surround Resonant frequency 25Hz. Frequency response to 13KHz. Sensitivity 95dB. Impedance 8ohm. **Attractive blue cone with aluminium centre dome.**
Price **£17.99** each + £3.00 P&P.



B.K. ELECTRONICS DEPT.EK

37 Whitehouse Meadows, Eastwood, Leigh-on-Sea, Essex SS9 5TY

★ SAE for current lists. ★ Official orders welcome. ★ All prices include VAT. ★ Mail order only. ★ All items packed (where applicable) in special energy absorbing PU foam. Callers welcome by **prior** appointment, please phone 0702-527572.

D.R. & J.G. TAYLOR

24 Beckenshaw Gardens, Woodmansterne, Banstead, Surrey SM7 3NB, Tel. 073 73 54474

PROJECTS

Talking Board	TMS 5100	£ 78.00
Softy 2		£194.35
Mini Organ	82020	£ 85.50
Ioniser	9283	£ 15.00
Ioniser Case		£ 8.00
Humidity Sensor	81567	£ 15.00
Pest Pester	80130	£ 6.00
Metal Detector Kit (Complete)	82021	£119.60
Casework only	82021A	£ 86.00
Meter	MD1	£ 6.40
Head only	82021B	£ 28.75
Head & Pole Set	82021C	£ 41.32
T.V. Games Extended	81143	£ 60.79
Disco Ceiling Lights	81012	£ 80.90
Disco Light Controller	81155	£ 19.83
LCD Frequency Counter	82026	£ 49.50

Elektor, Boards, Books, & Software
Test Equipment, CB and accessories — send s.a.e. for details.

Other Elektor Kits stocked, write or phone to check availability.
N.B. Power supplies & Cases not normally supplied with kits.
All above prices include VAT, Postage and Packing.

ZX Spectrum Program	'Specman'	£ 4.00
ZX 81 Programs.	'Gobla'	£ 3.00
	'Rally'	£ 3.00

For your ZX Spectrum. Amplifier/Speaker
Standard Mike-Ear outputs, no unplugging £ 14.95

THE ELEKTOR METAL DETECTOR

Kit no. 82021. An advanced metal detector available in kit form to the home constructor. Professional quality ABS vacuum formed case, complete with 10" ready set up and foamed search head. This kit can be constructed easily in a few hours. High performance specification includes phase locked loop oscillator and discriminator circuitry giving four reject modes with ground effect elimination.

40p for reprint of Elektor Projects
35p for 82021 Circuit Modifications only
Allow 28 days for delivery.
Hours of Business Mon. - Frid. 9.30 to 5.30
Payment with order, cheque/P.O. only to
D.R. & J.G. Taylor No 2 Business A/C

READERS' CLASSIFIED ADS

We invite our readers to insert advertisements into our 'Classified Section'.

If you have something to sell, exchange, or buy, fill in this form and send it to us with your remittance.

The rate (prepaid) is 20p per word. Minimum charge is £2.40 (12 words). Please read Conditions of Acceptance on Classified ads page.

When completing the form use CAPITAL LETTERS, one word per box. Your advertisement must include your address or telephone number. Please also add your name and full address below.

NAME: . . . .

ADDRESS: . . . .

WHO AND WHERE

AREA 1

CASEY BROTHERS
Palladium House
Boundary Road
St. Helens
Merseyside WA10 2LL
Tel. 0744 27873

DOUGLAS
90 Wellington Street
Stockport
Cheshire SK1 3AO
Tel. 061 480 8971

D.I.M.E.S. ELECTRONICS
Hobby Shop
1/3 Ellis Street
Peterhead
Grampian AB4 6JR
Tel. 0779 77515

ELECTRONIC ASSEMBLY SERVICES
Bright Street Works
Bury, Lancs. BL9 6AQ
Tel. 061 764 7634

ELECTRO SUPPLIES
6A Todd Street
Manchester
Tel. 061 834 1185

ELECTROVALUE LTD.
680 Burnage Lane
Manchester M19 1NA
Tel. 061 432 4945

A. MARSHALL (London) LTD.
85 West Regent Street
Glasgow G2 2QD
Tel. 041 332 4133

PROGRESSIVE RADIO
93 Dale Street
Liverpool L2 2JD
Tel. 051 236 0982

SHUDEHILL SUPPLY CO. LTD
53 Shudehill
Manchester M4 4AW
Tel. 061 834 1449

SPECTRON ELECTRONICS MANCHESTER LTD.
7 Oldfield Road
Salford
Greater Manchester
Tel. 061 834 4583

AREA 2

CARDIGAN ELECTRONICS
Chancery Lane
Cardigan
Dyfed
Tel. 0239 4483

CRYSTAL ELECTRONICS
209 Union Street
Torquay, Devon
Tel. Torquay 22699

DURRANT RADIO (COMPONENT SERVICE)
9 St. Mary's Street
Shrewsbury, Shropshire
Tel. 61239

L.F. HANNEY
77 Lower Bristol Road
Bath BA2 3BS, Avon
Tel. 0225 24811

LIGHTNING ELECTRONIC COMPONENTS
18 Victoria Road
Tamworth
Staffs B79 7HR
Tel. 0827

MONOLITH ELECTRONICS CO. LTD.
5/7 Church Street
Crewkerne
Somerset
Tel. 0460 74321

P.A.T.H. ELECTRONIC SERVICES
369 Alum Rock Road
Birmingham B8 3DR
Tel. 021 327 2339

RAMAR ELECTRONIC SERVICES LTD.
Masons Road
Stratford-on-Avon CV37 9NF
Tel. 4879

STEVE'S ELECTRONICS SUPPLY COMPANY
45 Castle Arcade
Cardiff CF1 2BU
Tel. 0222 41905

STERLING ELECTRONICS
20 Edward Street
Birmingham B1 2RX
Tel. 021 236 5036

AREA 3

AMBIT INTERNATIONAL
200 North Service Road
Brentwood
Essex
Tel. 0277 230909
Telex 995194 Ambit G

AUDIO ELECTRONICS
301 Edgware Road
London W2 1BN
Tel. 01 724 3564

BASIC ELECTRONICS LTD.
18 Epsom Road
Guildford
Surrey GU1 3JN
Tel. 0483 39984

BEST ELECTRONICS (SLOUGH) LTD.
24 Crown Road
Marlow SL7 2QG
Tel. 0628 74545

BI-PAK SEMICONDUCTORS
3 Baldock Street
Ware, Herts
Tel. 0920 61593

CAVERN ELECTRONICS
94 Stratford Road
Wolverton
Milton Keynes
Tel. Milton Keynes 314925

CHARLES TOWN
89 Carrington Street
Nottingham
Tel. 868933 & 55489

CRICKLEWOOD ELECTRONICS LTD.
40/42 Cricklewood Broadway
London NW2 3ET
Tel. 01 452 0161

C.T.S. LTD.
20 Chatham Street
Ramsgate
Kent CT11 7PP
Tel. Thanet 54072

ELECTROVALUE LTD.
28 St. Judes Road
Englefield Green
Egham
Surrey TW20 0HB
Tel. Egham 33603

ELEY ELECTRONICS
100/104 Beatrice Road
Leicester
Tel. 871522

J.T. FILMER
82 Dartford Road
Dartford
Kent DA1 3ER
Tel. 0322 24057

FOREWAY SERVICES
19 Old High Street
Headington
Oxford
Tel. 0865

FRANK MOZER LTD.
5 Angel Corner Parade
Edmonton
London N18
Tel. 01 807 2784

G.B. GARLAND BROS. LTD.
Chesham House
Deptford Broadway
London SE8 4QN
Tel. 01 692 4412

HARRINGTON COLORVISION
9 Queen Street
Colchester
Essex
Tel. Colchester 47503

HENRY'S RADIO
404 Edgware Road
London W2
Tel. 01 723 5095

KAYS ELECTRONICS
195 Sheffield Road
Chesterfield
Derbyshire
Tel. 0246 31696

MAPLIN ELECTRONIC SUPPLIES LTD.
P.O. Box 3
Rayleigh
Essex SS6 8LR
Tel. 0702 552911

Shops at:
159-161 King Street
Hammersmith
London W6
Tel. 01 748 0926
and
284 London Road
Westcliff-on-Sea
Essex
Tel. 0702 554000

BRADLEY MARSHALL LTD.
325 Edgware Road
London W2
Tel. 01 723 4242

MAYDALE ELECTRONIC SERVICES
2 Wellesley Parade
Godstone Road
Whyteleafe
Surrey CR3 0BL
Tel. 08832 5169

THE MODERN BOOK CO.
19-21 Praed Street
London W2 1NP
Tel. 01 402 9176
(Elektor books only)

NOBLE ELECTRONICS
85A - 87B George Street
Altrincham
Cheshire WA14 1RN
Tel.: 061 4510/4757

PHONOSONICS
22 High Street
Sidcup
Kent DA14 6EH
Tel. 01 302 6184

T. POWELL
Advance Works
44 Wallace Road
London N1
Tel. 01 226 1489

QC TRADING
21 Green Lanes
Palmers Green
London N13 4TT
Tel. 01 889 7593

BRIAN J. REED
161 St. John's Hill
Battersea
London SW11
Tel. 01 223 5016

SERVIO RADIO LTD.
156 Merton Road
South Wimbledon
London SW19 1EG
Tel. 01 542 6525

TECHNOMATIC LTD.
17 Burnley Road
London NW10 1ED
Tel. 01 452 1500
Telex 922800

THAMES VALLEY ELECTRONICS
24 High Street
Burnham
Bucks. SL1 7JH
Tel.: 06286 65882

TK ELECTRONICS
11 Boston Road
London W7 3SJ
Tel. 01 579 9794

BICC-VERO ELECTRONICS LTD.
Retail Dept.
Industrial Estate
Chandlers Ford
Hants. SO5 3ZR
Tel. Chandlers Ford 62829.

A DIRECTORY OF ELECTRONIC COMPONENT SUPPLIERS TO ELEKTOR READERS
IF THERE IS A COMPONENT SHOP IN YOUR AREA NOT LISTED ABOVE PLEASE LET US KNOW

AND WHERE WHO AND W

AREA 4

CHIP ELECTRONIC SERVICES
37 Great William O'Brien Street
Cork
reland
Tel. 021 502428

WM. B. PEAT & CO. LTD.
25/26 Parnel Street
Dublin
reland
Tel. 749973/4

ELECTRONIC CENTRE
6 College Square East
Belfast BT1 6DE
Tel.: Belfast 27357

ELECTRONIC WORLD –
LIMERICK
Parnell Street
Limerick
reland
Tel. 061 41233

NEWBURN ELECTRONICS
8 Manse Road
Ballycarry
Carrickfergus
Co. Antrim
el. 09603 78330

INTERNATIONAL

Australia

RANK MATHIAS
15 George Street
opp. Rawson Place)
ydney 2000
ustralia
el. 211 - 5003
lektor magazine, back issues and books
nly are available)

BELGIUM

ADELEC ELECTRONICS
4-26 Avenue de l'Heleport
000 Bruxelles
el. 02 218 26 40
elex 26061

ENMARK

N ELEKTRONIK
araldsgade 69
K 2100 København
l. 01 18 20 02
lex 27255 bnelco dk

N ELEKTRONIK
yngby Hovedgade 9a
K 2800 Lyngby
l. 02 88 1900

ANSK MINI RADIO
r. Farimagsgade
7 59
364 Copenhagen K

OBBY ELECTRONICS
Nedergade
00 Odense

REDERIKSHAVE HOBBY
LEKTRONIK
Havnegade
0 Frederikshavn

K ELECTRONIC
Skoletorvet
600 Silkeborg

HOLTE ELEKTRONIK
Holte Midpunkt
2840 Holte

LILLIE ELEKTRONIK
89 Sondergade
6500 Vojens

AAGE NIELSENS EFTF
1 Sortedam Dosseringen
2200 Copenhagen
Tel. 01 39 30 10
Telex 27590 AANIL

ROTEC
16 Jernbanegade
4800 Nykobing Falster

FINLAND

AMERTRONICS OY
Vesijarvenkatu 33
SF - 15140 Lahti 14
Finland

BEBEK ELECTRONIC KY
Rautatienkatu 16
SF - 15110 Lahti 11
Tel. 918 - 40666

BEBEK ELECTRONIC
Pui Jonkatu 26 - 28
SF - 70100 Kuopio 10
Tel. 971 - 117667

ICELAND

SAMEIND HF
PO Box 7150
Grettisgata 46
127 Reykjavik
Iceland
Tel. 91 - 21366

INDIA

PRECIOUS ELECTRONICS
CORPORATION
3 Chunam Lane
Dadasaheb Bhadkamker Marg
Bombay 400 007
Tel. 367459/369478
also at
9 Athipattan Street
Mount Road
Madras 600 002
Tel. 842718

RADIO & CRAFT
PUBLICATIONS
376 Lajpat Rai Market
Delhi - 110006
Tel. 237147/269548

INDONESIA

INEL CO.
Jln. Aceh No. 61
Bandung
Indonesia
P.O. Box 398
Tel. Bandung 59544

ISRAEL

ZUR ELECTRONIC
CENTER LTD.
1 Hagidem Streer
Menora Square
Jerusalem

DIFFUSION DU LIVRE
FRANCAIS LTD.
Boite Postale 3172
35 Rue Rashi
Tel. Aviv
Tel. 289075

"YAIR"
1, Hahashmal St.
P.O. Box 1941
Tel Aviv 61019
Tel. 624057/624398

JORDAN

GENERAL ELECTRONICS
CORP.
United Insurance Building
King Hussein Street
P.O. Box 182099
Amman
Tel. 24347
Telex 21262 NADERC - JO
Cable NADERCO Amman

NEW ZEALAND

WAIKATO V.H.F. GROUP INC.
P.O. Box 606
Hamilton

NORWAY

BLEKEN ELEKTRONIKK A/S
Raadyrveien 32B
N-3160 Stokke
Tel. 033-36162

OSLO HOBBYSENTER A/S
Herslebsgt. 14-15
Oslo 5
Tel. 02 679050

SCANELCO A/S
P.O. Box 53
N-5047 Stend
Tel. 05 276885

PORTUGAL

TABACARIA BRITANICA
Praca do Duque da
Terceira, 19
1107 Lisboa Codex
Tel. 324752

SINGAPORE

DEVICE ELECTRONICS
(PTE) LTD.
104 - 1st Floor
Singapore Electrical and
Electronics Hardware Centre
Maude Rd./Kitchener Rd.
Singapore 0820
Tel. 2986455
Telex. No. 33250

S. AFRICA

PHILTRON PTY. LTD.
P.O. Box 2749
Pretoria 0001

SWEDEN

COILTRONIC
Box 38
183 21 Taby
Tel. 08 768 32 61
Telex 15326 Elektet

DATA SELECT ELECTRONICS
Box 146
S - 183 22 Taby
Tel. 46 762 514 16

INKO'X AB
Box 1057
721 27 Vasteras

JOSTY KIT, AB
Box 3134
200 22 Malmö 3

KITEL DISTRIBUTION
Box 6047
S-162 06 Vallingby

MICRO KIT
Box 8060
S-720 08 Veasteraas
Tel. 021 117079

TURKEY

ABC KITABEVI
Tunel Meydani 1
Beyoglu
Istanbul
Tel. 442581

DIRECTORY OF ELECTRONIC COMPONENT SUPPLIERS TO ELEKTOR READERS
THERE IS A COMPONENT SHOP IN YOUR AREA NOT LISTED ABOVE PLEASE LET US KNOW

eps-service

Many Elektor circuits are accompanied by designs for printed circuits. For those who do not feel inclined to etch their own printed circuit boards, for their own use only, a number of these designs are available as ready etched and pre-drilled boards. Delivery time is approximately three weeks, U.K./air mail.

Example:

digisplay	(E13)	9376	3.25	7.25
1	2	3	4	5

1. Circuit title
2. reference to associated article(s)
3. board number

U.K.:

4. price (in £) inclusive of 15% VAT

U.S.A. and Canada:

5. price in $, not including tax (if any)

		£	$
E26: JUNE 1977			
formant: keyboard interface (E25)	9721-1	3.35	8.—
E29: SEPTEMBER 1977			
formant (E25, E26):			
interface receiver	9721-2	1.40	3.50
power supply	9721-3	5.50	13.—
keyboard divider (one octave)	9721-4	1.30	3.—
E31: NOVEMBER 1977			
formant (E25 . . . E30):			
VCO	9723-1	9.90	23.50
experimenting with the SC/MP:			
RAM-I/O	9846-1	6.90	16.50
SC/MP board	9846-2	2.60	6.—
E32: DECEMBER 1977			
formant (E25 . . . E31):			
VCF	9724-1	4.35	10.50
experimenting with the SC/MP (E31): CPU	9851a	12.90	31.—
E33: JANUARY 1978			
simple function generator	9453	3.25	8.—
formant (E25 . . . E32):			
ADSR	9725-1	4.20	10.—
UAA 180 LED voltmeter (two boards)	9817	2.70	6.50
experimenting with the SC/MP (E31, E32):			
bus board (E57)	9857	4.—	9.50
memory card	9863	12.60	30.—
E34: FEBRUARY 1978			
formant (E25 . . . E33):			
DUAL-VCA	9726-1	4.35	10.50
experimenting with the SC/MP (E31 . . . E33):			
HEX-I/O	9893	18.20	43.50
E35: MARCH 1978			
formant (E25 . . . E34):			
LFO module	9727-1	4.50	11.—
noise module	9728-1	4.—	9.50
4 k RAM card	9885	14.70	35.—
E36: APRIL 1978			
formant (E25 . . . E35):			
COM	9729-1	4.—	9.50
elektornado	9874	3.55	8.50
cassette interface	9905	3.—	7.—
E38: JUNE 1978			
mini-counter	9927	3.15	7.50
E39/40: SUMMER CIRCUITS 1978			
preconsonant	9954	2.25	5.50
E41: SEPTEMBER 1978			
formant			
24 dB VCF	9953-1	4.10	10.—
E42: OCTOBER 1978			
resonance filter module	9951	4.45	10.50
VHF/UHF modulator	9967	1.55	4.—
E43: NOVEMBER 1978			
ASCII keyboard	9965	7.70	18.50
E44: DECEMBER 1978			
elekterminal	9966	7.50	18.—
E48: APRIL 1979			
TV games computer:			
UHF/VHF modulator (see E42, October 1978)	9967	1.55	4.—
main board and documentation	79073	19.95	47.50
power supply	79073-1	2.45	6.—
keyboard p.c.b.	79073-2	3.65	8.50
Complete set of four boards (9967, 79073, 79073-1, 79073-2), documentation and one ESS software record (ESS 006):		26.25	62.50
E49: MAY 1979			
Interface for µPs	79101	1.40	3.50
E50: JUNE 1979			
stereo decoder	79082	2.40	5.50
E53: SEPTEMBER 1979			
parametric equaliser,			
filter section	9897-1	1.65	4.—
tone control section	9897-2	1.65	4.—
E55: NOVEMBER 1979			
topamp	80023	1.45	3.50
E56: DECEMBER 1979			
SEWAR	80009	2.85	7.—
steam train	80019	1.90	4.50
E57: JANUARY 1980			
digital tuning scale (two boards)	80021-1/2	7.05	17.—
new bus board (E33)	80024	5.85	14.—
E58: FEBRUARY 1980			
aerial amplifier	80022	1.85	4.50
elektor vocoder,			
bus board 1	80068-1	9.90	23.50
bus board 2	80068-2		
filter board	80068-3	3.45	8.—
input/output board	80068-4	3.20	7.50
supply board	80068-5	2.85	7.—
E59: MARCH 1980			
chorosynth	80060	22.15	53.—
E60: APRIL 1980			
aide-de-camp: 12 V/2 A	7043B	1.10	2.50
transistor ignition	80084	3.90	9.50
E61: MAY 1980			
BASIC cassette interface	80050	5.60	13.50
PWM amplifier	80085	1.50	3.50
Junior computer:			
main board	80089-1	12.60	30.—
display board	80089-2	1.30	3.—
supply board	80089-3	3.—	7.—
E63/64: SUMMER CIRCUITS 1980			
STAMP amplifier	80543	1.40	3.50
PROM programmer	80556	3.85	9.—
E65: SEPTEMBER 1980			
8K RAM + EPROM card	80120	13.15	31.50
E67: NOVEMBER 1980			
central heating pump control	81019	2.55	6.—
fridge alarm	81024	1.45	3.50
E69: JANUARY 1981			
big VU meter			
low voltage board	81085-1	2.30	5.50
main board	81085-2	2.45	6.—
E70: FEBRUARY 1981			
voiced/unvoiced detector			
detector board	81027-1	3.40	8.—
switch board	81027-2	4.05	9.50
E71: MARCH 1981			
MW receiver	81111	1.95	4.50
multiple sound effects generator	81112	2.05	5.—
High Com:			
2 complete modules (built and tested) + 1 main board + self-adhesive front panel	81117-1	35.70	85.—
power supply	81117-2	2.05	5.—
UAA LED voltmeter (2 boards)	9817	2.70	6.50
peak programme meter	9860	2.—	5.—
E72: APRIL 1981			
transistor match-maker	81123	1.75	4.—
intelekt	81124	5.65	13.50
universal power supply	81128	2.45	6.—
E74: JUNE 1981			
Junior Computer			
interface board	81033-1	19.05	45.50
−12 V supply	81033-2	1.45	3.50
adaptor board	81033-3	1.30	3.—
storage scope	81141	3.80	9.—
E75/76: SUMMER CIRCUITS 1981			
continuity tester	81151	1.25	3.—
loudspeaker peak indicator	81515	1.50	3.50
random number generator	81523	2.40	6.—
'hi-fi' siren	81525	1.95	4.50
crystal tuning fork	81541	1.70	4.—
humidity sensor	81567	1.60	4.—
hi-fi preamplifier	81570	4.35	10.50
input buffers for the logic analyser	81577	2.—	5.—
E77: SEPTEMBER 1981			
TV games computer extension board	81143	19.—	45.—
disco light controller	81155	3.20	7.50
DFM + DVM	81156	4.25	10.—
revolution counter	81171	4.90	11.50
digital barometer	81173	3.50	8.50
E78: OCTOBER 1981			
RF-test generator	81150	1.60	3.80
economical fridge defroster	81158	1.80	4.35
EPROM programmer	81594	1.45	3.50
wide range dark room timer	82004	2.25	5.50
shutter speed meter	82005	3.75	9.—
LCD panel meter	82011	1.65	4.—
E79: NOVEMBER 1981			
teletext			
decoder board	82001-2	5.35	12.50
keyboard section	82001-3	3.15	7.50
sine-wave oscillator	82006	2.10	5.—
telephone amplifier	82009	1.55	3.50
power supply	9968-5A	1.40	3.50
mini organ	82020	3.50	8.50
metal detector	82021	5.65	13.50
LCD frequency counter	82026	2.—	5.—
high boost	82029	1.85	4.50
E80: DECEMBER 1981			
70cm transverter (Oct.)	80133	12.50	30.—
teletext			
receiver board	82001-1	4.10	10.—
video control board	82001-4	4.25	10.—
VHF-UHF converter board	9864	1.75	4.—
IPROM	82019	1.65	4.—
synthesiser VCO	82027	4.40	10.50
flashing light	82038	1.60	4.—
capacitance meter module	82040	2.—	5.—
E81: JANUARY 1982			
EPROM programmer	82010	4.65	11.—
synthesiser VCF + VCA	82031	4.25	10.—
E82: FEBRUARY 1982			
synthesiser ADSR	82032	4.20	10.—
synthesiser LFO	82033	3.90	9.50
10 W/70 cm amplifier	82043	2.50	6.—
teletext power supply	82065	1.55	3.50
talking board interface	82068	1.60	4.—
darkroom thermostat	82069	2.—	5.—
universal NiCad charger	82070	2.05	5.—
E83: MARCH 1982			
wind sound generator	82066	1.60	4.—
automatic squelch	82077	1.90	4.50
synthesiser COM	9729-1	4.—	9.50
synthesiser power supply	82078	3.70	9.—
bus board	82079	3.35	8.—
DNR noise reduction	82080	2.85	7.—
lead acid charger	82081	1.95	4.50
E84: APRIL 1982			
dynamic RAM card	82017	4.90	11.50
100 W amplifier	82089-1	2.60	6.—
100 W power supply	82089-2	2.40	5.50
2114 RAM tester	82090	1.90	4.50
connection tester	82092	1.55	3.50
mini EPROM card	82093	1.65	4.50
TV sound interface	82094	1.90	4.50

ORDERING INFORMATION Payment must be in advance.

1. **For UK and all countries except the USA: payment, incl. £ 0.50 postage and packing direct to Elektor Publishers Ltd., or via bank transfer to The Midland Bank Ltd., Canterbury, A/C no. 11014587, sorting code 40-16-11.**
2. **For the USA only: Please make your cheque/money order payable to Elektor Publishers Ltd., Bank of America, c/o File No. 1504, 1000 W. Temple, Los Angeles, Cal. 90074, A/C no. 12350-04207. Prices include post & packing, surface mail. If air mail, please add $ 1.50.**

eps-service

E85: MAY 1982

6502 housekeeper			
main board	81170-1	4.05	9.50
display board	81170-2	3.05	7.50
elektor artist	82014	10.05	24.—
Z80-A CPU card	82105	7.05	17.—
polyformant:			
debounce unit	82106	2.45	6.—
input unit	82107	4.65	11.—
tune shift	82108	2.75	6.50
prop-tachometer	82116	2.10	5.—

E86: JUNE 1982

the 'Poly bus'	82110	3.35	8.—
talking clock	82121	3.15	7.50
compact shortwave SSB receiver	82122	5.—	12.—
fluorescent tube dimmer	82128	1.60	4.—
solid state relay	82131	1.55	3.50
electronic dog whistle	82133	1.50	3.50
electronic fluorescent light starter	82138	1.35	3.—

E87/88: SUMMER CIRCUITS 1982

polyformant:			
output unit	82111	4.70	11.—
D/A converter	82112	1.90	4.50
stereo power amplifier	82527	1.60	4.—
light-sensitive switch	82528	1.60	4.—
tape playback preamp	82539	1.60	4.—
sound effects generator	82543	2.40	5.50
slave flash	82549	1.45	3.50
5 V power supply	82570	2.20	5.—

E89: SEPTEMBER 1982

rugby MSF receiver	80524	5.80	15.—
darkroom computer part I			
keyboard	82141-1	3.75	9.—
keyboard interface	82141-2	2.—	5.—
display	82141-3	2.25	5.50
gas detector	82146	1.60	4.—
house telephone system:			
main board	82147-1	3.—	7.—
power supply	82147-2	1.50	3.50
three phase tester	82577	2.70	6.50
TV games:			
'rapid loader'	82558-1	3.45	8.—
EPROM plug-in board	82558-2	1.95	4.50

E90: OCTOBER 1982

darkroom computer part II			
light meter	82142-1	1.75	4.—
temperature meter	82142-2	1.60	4.—
process timer	82142-3	2.—	5.—
active antenna:			
R.F. board	82144-1	1.55	3.50
power supply	82144-2	1.55	3.50
digital thermometer	82156	2.15	5.—
wave shifter for SSB:			
low frequency converter	82161-1	2.05	5.—
high frequency converter	82161-2	2.30	5.50

E91: NOVEMBER 1982

model train lighting	82157	4.05	9.50
floppy disk controller	82159	4.70	11.—
guitar tuner	82167	2.20	5.—
cerburus	82172	2.35	5.50

E92: DECEMBER 1982

in-car ioniser			
power supply	82162	1.50	3.50
main board	9823	4.20	10.—
precision power supply	82178	4.05	10.—
triopodus electrus diclopus	82179	2.95	7.—
crescendo	82180	4.60	11.—

NEW

E93: JANUARY 1983

3 A computer			
power supply	83002	1.85	4.50
milli-ohmmeter	83006	1.90	4.50
crescendo			
d.c. protection and countdown	83008	3.—	7.—

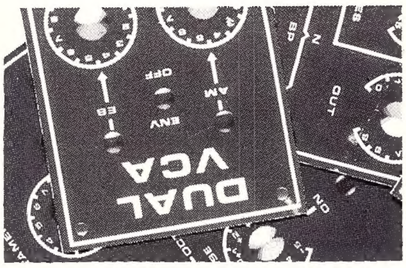
front panels

front panels for Formant (E25 . . . E35)

interface	9721-F	1.60	4.—
VCO	9723-F	1.60	4.—
VCF	9724-F	1.60	4.—
ADSR	9725-F	1.60	4.—
DUAL-VCA	9726-F	1.60	4.—
LFOs	9727-F	1.60	4.—
NOISE	9728-F	1.60	4.—
COM	9729-F	1.60	4.—

Complete set of 11 panels (includes 3 x VCO and 2 x ADSR): £ 15.80 or $ 37.50

24 dB VCF (E41)	9953-F	1.60	4.—
resonance filter module (E42)	9951-F	1.60	4.—
simple function generator (E33, E38)	9453-F	2.50	6.—
Elektor Artist (E85)	82014F	1.70	4.—
precision power supply (E92)	82178F	1.90	4.50



software

45 RPM records with μP programs

singing SC/MP: well-known Christmas melodies, both as SC/MP program and 'live'	ESS 002	1.40	3.50
NIBL-E	ESS 004	1.40	3.50
for SC/MP: Luna, battleships, keyplay, runtext, biorhythm tracer, disassembler	ESS 005	2.20	5.50

cassette with μP programs

μP TV games: 15 programs: jackpot, reversie, amazone, code breaker, etc.	ESS 007	4.25	10.50
μP TV games: 15 programs: invaders, fishing, maze adventure, memory, pontoon, nim, etc.	ESS 009	5.25	12.50

NEW μp TV games

15 programs: aliens, flipper, helicopter, pilot, basketball, hangman etc.	ESS 010	5.25	12.50

ORDERING INFORMATION **Payment must be in advance.**

1. **For UK and all countries except the USA: payment, incl. £ 0.50 postage and packing direct to Elektor Publishers Ltd., or via bank transfer to The Midland Bank Ltd., Canterbury, A/C no. 11014587, sorting code 40-16-11.**
2. **For the USA only: Please make your cheque/money order payable to Elektor Publishers Ltd., Bank of America, c/o File No. 1504, 1000 W. Temple, Los Angeles, Cal. 90074, A/C no. 12350-04207. Prices include post & packing, surface mail. If air mail, please add $ 1.50.**

classified ads

CONDITIONS OF ACCEPTANCE OF CLASSIFIED ADVERTISEMENTS

1. Advertisements are accepted subject to the conditions appearing on our current rate card and on the express understanding that the Advertiser warrants that the advertisement does not contravene any Act of Parliament nor is it an infringement of the British Code of Advertising Practice.

2. The Publishers reserve the right to refuse or withdraw any advertisement.

3. Although every care is taken, the Publishers shall not be liable for clerical or printer's errors or their consequences.

4. The Advertiser's full name and address must accompany each advertisement submitted.

The prepaid rate for Classified Advertisements is 20 pence per word (minimum 12 words). Semi-display setting £5.50 per single column centimetre (minimum 2.5 cms.). All cheques, postal orders, etc. to be made payable to Elektor Publishers Ltd. Treasury notes should always be sent by registered post. Advertisements, together with remittance, should be sent to the Classified Advertisement Manager, Elektor Publishers Ltd., 10 Longport, Canterbury, Kent CT1 1PE.

FANTASTIC OFFER. 200 assorted top specification IC's in manufacturer's tubes plus 10 red LED's and 2 optoisolator IC's (worth **£ 2.50** alone) plus 44 page Catalogue no. 19 packed with thousands of bargains for those with electronic and mechanical interest.
Price **£ 6.00** including VAT and postage.
J.A. CREW & CO., SPINNEY LANE,
ASPLEY GUISE,
MILTON KEYNES MK 17 8JT.

R & B ELECTIQUE.

1N4007	**£ 0.06**
BC 109C	**£ 0.13**
TIP 3055	**£ 0.59**
2N3053	**£ 0.25**
Prices each.	
Postage & Packing	**£ 0.50**

R & B ELECTIQUE,
3, Shute End,
Wokingham,
Berks. RG11 1BH.
MAIL ORDER ONLY.

PARAPHYSICS JOURNAL (Russian translations): Psychotronic Generators, Kirlianography, gravity lasers, Telekinesis. Details: S.A.E. 4 x 9" to PARALAB, DOWNTON, WILTS.

PRINTED CIRCUITS. Make your own simply, cheaply and quickly. Golden Fotolak Light Sensitive Lacquer – now greatly improved and very much faster. Aerosol cans with full instructions £ 2 25. Developer 35 p. Ferric Chloride 55 p. Clear Acetate sheet for master 14 p. Copper-clad Fibreglass Board approx. 1 mm thick £ 1.75 sq. ft. Post & packing 60 p.
WHITE HOUSE ELECTRONICS,
P.O. BOX 19,
PENZANCE, CORNWALL.

EXPERIMENTER'S PRINTED CIRCUIT KIT
Build 50 Interesting Projects on a Printed Circuit Chassis with parts from your 'Junk-Box'. 4 assorted Boards, Resist, Etchant, Solvent, Degreaser, Instruction Manual, plus '50 Suggested Projects' Circuits, Chassis Plans, Part Layouts for Radio Receivers, Transmitters, Amplifiers, Alarms, Instruments, Testers, Radio Control, Gadgets etc. Price: **£ 2.50** Post & Pack. **50p.**
PHOTOELECTRIC ALARM KIT
Phototransistor, Transistors, Diode, Relay, Resistors, Chassis & Case. Price: **£ 4.50** Post & Pack. **50p.**
INVISIBLE-BEAM OPTICAL KIT
for the above 2 lenses, 2 mirrors, 2 wooden blocks, Infra-red filter, lamp holder etc. Price: **£ 3.70** Post & Packing **30p.**
Send S.A.E. for full details of all kits & circuits.
EXPERIMENTAL ELECTRONICS
335 Battersea Park. Road. London S.W.11
tel. 01-720-2683

NEW COMPONENT SALE
ITT BC 183 Transistors . . . . . . **4p** each 10 for **30p**
ITT 1N4002 Diodes . . . . **3p** each 10 for **25p**
OPTRON TYPE OP10 INFRA RED DIODE. High output power. Spectrally and mechanically matched to the OP500 and OP500SL series photo transistors. Stable characteristics. Usually over **£1**. Our price **40p** each. 3 for **£1**. Data sheet if required 10p extra. BRIDGE RECTIFIERS. (Philips). 400 PIV at 4 amp. Well made. Should be over **£2** each. Our price **90p** p.p. **20p**.

RIDICULOUS RESISTOR SALE
¼ watt carbon film resistors. 5% tol. High quality resistors made under exacting conditions by automatic machines. E12 range 1RO to 10MO. Lot A. 1000. (25 per value). **£8**. Lot B. 500 (25 per value) **£4.25**. Lot C 100 (25 per value) **90p**. Orders over **£5** post free. Otherwise postage 15p in £1.
1000 PCB type RESISTORS. **£2.50**. Bulk purchase enables to offer 1000 mixed preformed. 5% tol. carbon film resistors for PCB mounting. Huge range of preferred value **£2.50** per 1000. 4000 for **£8.** Postage 15p in £1. Huge range of preferred valves at **£2.50** per 1000. 4000 for **£8.**

HAVE YOU SEEN THE GREEN CAT? 1000s of new components, electronic, radio, audio at unbelieveble low prices. Send 50p (refundable) and receive catalogue and FREE RECORD SPEED INDICATION. Try a JUMBO PACK. Contains transistors, resistors, caps, pots, switches, radio and electronic devices. Over **£50** worth for **£11**. Carriage **£2.50**. MINI JUMBO PACK (**£20** worth) for **£5** p.p. **£1.50**.
PLEASE ADD 15V.A.T. to all orders including carriage. Dept. E. K. MYERS ELECTRONICS. 12, Harper Street, Leeds LS2 7EA. Opposite Joe Corals Callers welcome. 9 to 5. Mon-Sat. Lunch 2.15 to 3.15 Tel. 452045.

advertisers index

Ambit International 1-1
Amtron U.K. Ltd. 1-1

B.K. Electronics 1-6
Bradley Marshall 1-1

C.D.S. 1-1
Cricklewood Electronics . . 1-64/1-6

Douglas Electronic Components 1-6

Electrovalue Ltd. 1-0

Gemini Electronic Components . 1-1

Maplin 1-7
Marshall's 1-1

T. Powell 1-1

Southern Technical Systems . . . 1-1

DR & JG Taylor 1-6
Technomatic 1-02/1-0
Thames Valley Electronics 1-7
Thandar Electronics Ltd. 1-1
TK Electronics 1-1

Watford Electronics 1-04/1-0

ALARMS!
WRITE OR PHONE FOR **FREE**
ILLUSTRATED CATALOGUE **NOW!**
A.D. ELECTRONICS
217, WARBRECK MOOR, AINTREE
LIVERPOOL
L9 0HV, 051 523 8440
BARCLAYCARD VISA

THE BRITISH AMATEUR ELECTRONICS CLUB
The British Amateur Club for all interested in electronics – 4 Newsletters a year, comprehensive technical library, help with electronics problems
Subscription **£ 4.50** in U.K. Overseas apply.
For details send S.A.E. to
Hon. Sec. J.G. Margetts,
3 Bishopstone Close, Golden Valley,
Cheltenham, Glos.

elektor copy service

Photocopies of articles can be obtained from out of print back issues of Elektor.
Send details of the name of the article required and the number of the back issue concerned, your name and address plus 50 p per cost of article and 20 p for postage and packing.

Remember to try us for ALL your component requirements

CMOS

4001	13p
4002	13p
4006	60p
4007	13p
4008	50p
4010	30p
4011	13p
4012	13p
4013	22p
4014	50p
4015	45p
4016	25p
4017	40p
4019	35p
4020	48p
4021	46p
4022	55p
4023	13p
4024	42p
4025	13p
4027	26p
4028	40p
4029	60p
4030	13p
4035	66p
4040	50p
4042	40p
4044	46p
4047	50p
4049	20p
4050	20p
4051	50p
4052	60p
4053	50p
4066	28p
4067	447p
4069	13p
4070	13p
4071	13p
4076	50p
4081	13p
4086	45p
4093	30p
4098	70p
4503	42p
4510	52p
4511	45p
4512	50p
4516	60p
4518	40p
4520	60p
4528	64p
4539	64p
4555	45p
4556	45p
40014	50p
40085	70p
40097	60p
40098	60p
40161	55p
40163	55p
40175	60p
40193	60p

TTL

7400	13p
7401	13p
7402	13p
7403	13p
7404	13p
7405	14p
7406	20p
7407	24p
7408	14p
7409	14p
7410	14p
7411	14p
7412	18p
7413	22p
7414	26p
7416	18p
7417	22p
7420	15p
7421	20p
7425	20p
7426	27p
7427	15p
7430	15p
7432	18p
7437	18p
7438	18p
7439	24p
7440	16p
7442	24p
7445	50p
7446	68p
7447	55p
7448	55p
7450	15p
7451	15p
7453	15p
7454	15p
7470	30p
7472	25p
7473	25p
7474	22p
7475	23p
7476	22p
7483	47p
7485	60p
7486	25p
7490	26p
7491	45p
7492	38p
7493	28p
7495	50p
7496	45p
74107	25p
74121	20p
74122	35p
74123	40p
74125	38p
74126	38p
74132	30p
74145	.50p
74150	90p
74151	40p
74153	45p
74154	75p
74155	45p
74157	35p
74158	30p
74161	45p
74163	45p
74164	60p
74165	65p
74166	70p
74167	120p
74170	120p

TTL contd.

74173	60p
74174	50p
74175	50p
74180	50p
74190	60p
74191	60p
74192	70p
74193	60p
74194	60p
74195	46p
74196	46p
74197	50p
74221	75p
74279	40p
74290	60p
74298	60p

TTL LS

74LS00	14p
74LS01	14p
74LS02	14p
74LS03	14p
74LS04	14p
74LS05	14p
74LS08	14p
74LS09	14p
74LS10	14p
74LS11	14p
74LS13	21p
74LS14	21p
74LS15	14p
74LS20	14p
74LS21	14p
74LS26	14p
74LS27	14p
74LS28	22p
74LS30	14p
74LS32	14p
74LS33	14p
74LS37	19p
74LS38	14p
74LS40	19p
74LS42	40p
74LS47	44p
74LS48	44p
74LS51	14p
74LS54	14p
74LS74	18p
74LS83	42p
74LS86	14p
74LS90	30p
74LS92	30p
74LS93	30p
74LS95	40p
74LS109	40p
74LS112	30p
74LS113	30p
74LS125	28p
74LS126	28p
74LS132	40p
74LS133	25p
74LS136	20p
74LS138	30p
74LS139	30p
74LS151	40p
74LS153	40p
74LS155	45p
74LS156	45p
74LS157	30p
74LS158	30p
74LS160	35p
74LS161	35p

TTL LS contd.

74LS162	35p
74LS163	35p
74LS164	45p
74LS165	50p
74LS168	60p
74LS169	60p
74LS170	70p
74LS173	40p
74LS174	45p
74LS175	45p
74LS181	110p
74LS190	45p
74LS191	45p
74LS192	45p
74LS193	45p
74LS194	50p
74LS196	35p
74LS197	50p
74LS240	70p
74LS241	70p
74LS244	70p
74LS245	80p
74LS247	60p
74LS249	40p
74LS251	40p
74LS253	35p
74LS256	55p
74LS257	40p
74LS258	40p
74LS259	65p
74LS260	30p
74LS266	22p
74LS273	60p
74LS279	40p
74LS283	40p
74LS290	34p
74LS293	34p
74LS295	52p
74LS299	111p
74LS322	90p
74LS323	130p
74LS347	55p
74LS352	60p
74LS353	60p
74LS365	30p
74LS366	35p
74LS367	30p
74LS368	30p
74LS373	75p
74LS374	75p
74LS375	40p
74LS377	70p
74LS378	60p
74LS379	60p
74LS390	50p
74LS393	50p
74LS395	48p
74LS447	45p
74LS490	64p
74LS502	80p
74LS503	90p
74LS533	80p
74LS534	80p
74LS540	80p
74LS670	100p

OPTO

LEDs

0·2″

Red	10p
Green	14p
Flashing Red	82p

Rectangular LEDs

Red	22p
Green	26p
Yellow	22p
Bi-Colour Red/Green	80p

0·125″

Red	11p
Green	12p
Yellow	12p

OPTO contd.

DISPLAYS

Bar Graph	295p

5″

Common Anode L.H. decimal point

Red	150p
Green	248p
Yellow	260p

Common Cathode R.H. decimal point

Red	150p
Green	248p
Yellow	260p

3″

Red	127p
Green	196p

LINEAR

AM2533	280p
LM324	45p
LM339	65p
LM358	75p
LM3900	55p
LM317	200p
MC1438	810p
MC1458	40p
MC1488	61p
MC1489	80p
MC1496	60p
MC3418	810p
NE555	30p
NE556	61p
TBA800	88p
TBA810	95p
TBA820	90p
TCA940	175p
TDA1170	250p
TDA2002V	250p
TDA2020	320p
TL071CP	32p
TL072CP	53p
TL497	300p
UA741	18p
UA747	70p
UA7805	45p
UA7812	45p
UA7905	54p
UA7912	54p
UA723	37p
ULN2003AN	100p

Bridge Rectifiers

50v 1.5A	23p
200v 1.5A	22p
400v 1.5A	30p
600v 1.5A	32p
800v 1.5A	35p

TOGGLE SWITCHES

SPDT on/none/off	48p
SPTD on/off/on	52p
DPDT on/none/off	56p
DPDT on/off/on	60p

SPECIAL

2N 3055 10 for 450p

Micro's Memories & Specials

Z80ACPUPS	550p
Z80ACTCPS	440p
Z80APIOPS	440p
Z80ADARTPS	550p
Z80ASIOPS	440p
8080A	335p
8035HL	500p
8085A4	500p
8202A	2200p
8253	750p
8255	299p
8251	310p
8224	250p
8228	250p
ICL7106	795p
ICL7107	975p
2732A-4	520p
2114A(450ns)	100p
2716	340p
2764	1592p
M108 single chip organ	1330p
M086 Tone generator	300p

Transistors & Diodes

IN4001	4p
IN4007	6p
IN5401	13p
IN5404	16p
IN5406	16p
IN4148	3p
IN914	3p
IN916	5p
BZY88C2V7	8p
BZY88C3V3	8p
BZY88C3V6	8p
BZY88C4V7	8p
BZY88C6V8	8p
BZY88C8V2	8p
BZY88C12	8p
BZY88C15	8p
BC107	11p
BC107A/B	11p
BC108A/B/C	11p
BC109A/B/C	12p
BC182	9p
BC183	9p
BC184	9p
BC212	9p
BCY70	17p
BCY71	18p
BCY72	18p
BFY50	28p
BFY51	28p
BFY52	28p
TIP29/A	30p
TIP30/A	35p
TIP31/A	45p
TIP32/A	45p
TIP/41A	50p
TIP42/A	50p
2N708	24p
2N918	26p
2N2218/A	26p
2N2219/A	28p
2N2221/A	24p
2N2222/A	28p
2N2904/A	29p
2N2905A	28p
2N2906A	28p
2N2907A	28p
2N3053	28p
2N3055	46p
2N3442	130p
2N3715	57p
2N3716	65p

'D' TYPE Connectors

	ml.	fml.
9	58p	78p
15	78p	1.12p
25	1.10p	1.60p
37	1.148p	2.63p
50	1.97p	3.02p

THAMES VALLEY ELECTRONICS LTD

CAPACITORS

Tant Beads 16v

.1uf	11p	6.8uf	18p
.22uf	11p	10uf	18p
.47uf	11p	15uf	30p
1.0uf	11p	22uf	35p
2.2uf	14p	33uf	48p
3.3uf	14p	47uf	80p
4.7uf	18p	68uf	110p

Tant Beads 35v

.1uf	13p	1.00uf	15p
.15uf	13p	1.5uf	15p
.22uf	13p	2.2uf	17p
.33uf	13p	3.3uf	17p
.47uf	13p	4.7uf	20p
.68uf	13p	6.8uf	20p
		10.0uf	27p

Plate Ceramics 63v

10pf	5p	47pf	5p
100pf	5p	220pf	6p
150pf	6p		

Disc Ceramics

.01 50v	2p	.1 50v	5p

SPECIAL OFFER

New Item

UNIVERSAL BATTERY CHARGER 955p

while stocks last only

Resistors Carbon Film ¼ watt

LOW VALUE PACKS
Pack of 200 (mixed values) 100p
Pack of 2000 (mixed values) 300p

other values
pack of 10 15p
pack of 100 100p

Low Profile DIL sockets

8pin	8p	24pin	21p
14pin	9p	28pin	25p
16pin	10p	40pin	28p
20pin	17p		

BARGAIN OFFER

2732 250ns

1 off 520p 10 off 470p

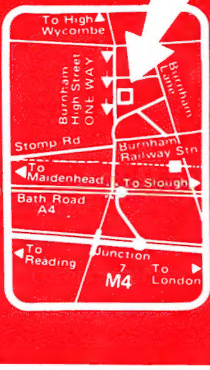
Plus Postage & Packing 45p

Please add VAT at 15%

Government and Educational establishments orders accepted.

PHONE US TO CHECK AVAILABILITY OF COMPONENTS MENTIONED IN THIS ISSUE

Moving TO NEW PREMISES Nov.1st.1982



Thames Valley Electronics Ltd

32 High Street
Burnham·Bucks
Telephone Burnham
(06286) 65882

MAPLIN
MAP 25 FREIGHT SHUTTLE
BUYER'S GUIDE TO ELECTRONICS AND HOME COMPUTERS
INSIDE FULL DETAILS OF Atari 400 & 800 Commodore 64 Commodore Max Dragon 32 VIC 20
Hundreds of software titles
HUGE RANGE OF QUALITY ELECTRONIC COMPONENTS & EQUIPMENT
£1.25

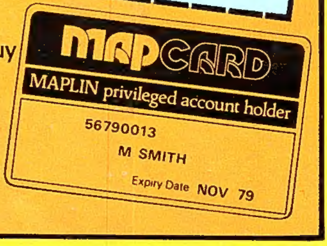
THE NEW MAPLIN CATALOGUE FOR 1983

BRINGS YOU RIGHT UP-TO-DATE IN ELECTRONICS & COMPUTING

ON SALE IN ALL BRANCHES OF WHSMITH FROM 18th NOVEMBER 1982 PRICE £1.25

Nearly 400 pages of all the most useful components and a whole big new section devoted to home computers and personal software. As always the catalogue keeps you up-to-date with the latest technology — even our ordinary miniature resistors are now superb quality 1% tolerance metal film, yet they're still only 2p each. As well as our usual quality products at low prices, now we're offering quantity discounts too. So pick up a copy of our catalogue now — it's the biggest *and* the best!

Send now for an application form — then buy it with MAPCARD. MAPCARD gives you real spending power — up to 24 times your monthly payments, instantly.



Post this coupon now for your copy of our 1983 catalogue, price £1.25 + 25p p&p. If you live outside the UK send £1.90 or 10 International Reply Coupons. I enclose £1.50.

Name ....

Address ....

....

....

E 1/83

MAPLIN
ELECTRONIC SUPPLIES LTD
P.O. Box 3, Rayleigh, Essex SS6 8LR.
Telephone: Southend (0702) 552911/554155

Shops at:
159-161 King Street, Hammersmith, London W6 Tel: (01) 748 0926
Lynton Square, Perry Barr, Birmingham. Telephone: (021) 356 7292
284 London Road, Westcliff-on-Sea, Essex. Tel: (0702) 554000
All shops closed Mondays